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PUBLIC NOTICES.

IN THE MATTER of LETTERS PATENT granted to WAYGOOD-OTIS LTD. of Falmouth-road Great Dover-street London S.E.1. (1) dated February 26th 1917 and numbered 107,356 for the invention of "An Improved Electric Lift System" and (2) dated September 11th 1917 and numbered 112,749 for the invention of "Improvements in Inclined Endless Conveyors or Escalators."

Notice is Hereby Given that on the 20th December 1932 an ORIGINATING SUMMONS (1932 W. No. 2919) issued out of the High Court of Justice (Chancery Division) on behalf of Waygood-Otis Ltd. (the Patentees) asking that the terms of each of the said Letters Patent may be extended for three years, will come before the Honourable Mr. Justice Luxmoore for directions as to the hearing and any person desirous of being heard in opposition must, at least seven days before that date, lodge notice of opposition (giving an address for service within the United Kingdom) at Room 175, Royal Courts of Justice, Strand, London, and serve a copy thereof upon the undermentioned solicitors and upon the Solicitor to the Board of Trade.

DATED 15th November, 1932.

COOTE and CO.,
60, Lincoln's Inn-fields,
London, W.C.2,
Upon whom all documents requiring service should be served. 9169

County Borough of Sunderland.

DEEP WATER QUAY. CONTRACT No. 7.
TO CONTRACTORS.

The Corporation of Sunderland is prepared to receive TENDERS for the following WORK upon a site adjoining the new Deep Water Quay on the River Wear at Sunderland, County Durham :—

(a) The Construction of a Reinforced Concrete Transit Shed and Warehouse and Works connected therewith.
(b) The Provision of Two Underhung Cranes of 1 ton working capacity in the above-mentioned Transit Shed.

The contract documents may be seen upon application to the Engineer for the scheme, Mr. W. H. S. Tripp, M. Inst. C.E., c/o River Wear Commissioners, St. Thomas-street, Sunderland, or may be obtained from him on payment of a deposit of Six Pounds in the case of the work described in paragraph (a), and Four Pounds in the case of the work described in paragraph (b). All cheques should be crossed and made payable to "The Corporation of Sunderland," and the deposits will be returned on receipt of a bona fide Tender from the depositor, accompanied by the whole of the documents issued.

Tenders, which will only be considered if made upon the forms supplied, must be completed in accordance with the detailed Instructions incorporated in the documents, endorsed "Tender for Deep Water Quay," and delivered at the office of the undersigned, Town Hall, Sunderland, not later than Noon on the 5th December, 1932.

The Corporation do not bind themselves to accept the lowest or any Tender.

G. S. McINTIRE,
Town Clerk.

Town Hall,
Sunderland,
15th November, 1932. 9167

Fulham Borough Council.

POWER STATION EXTENSIONS.

The Fulham Borough Council is prepared to receive TENDERS for the following WORKS in connection with the Extension of the Council's Power Station in Townmead-road, Fulham, viz.:—

SECTION "G."

(a) The EXCAVATION on the SITE of approximately 60,000 Cubic Yards of GROUND, principally below Ordnance Datum.
(b) The BUILDING of a REINFORCED CONCRETE FOUNDATION RAFT, with Concrete Retaining Walls, up to ground level.

The specification, drawings, &c., may be inspected at the office of Messrs. Preece, Cardew and Rider, 8 and 10, Queen Anne's-gate, S.W.1, on and after 21st November next.

The site may be viewed upon the presentation of an order to the gatekeeper at the entrance to the Power Station. Orders to view will be issued on application to Messrs. Preece, Cardew and Rider as above.

Copies of the specification, drawings, &c., will only be issued to persons or firms who have successfully carried out works of a similar nature and magnitude, and may be obtained by such persons or firms from Messrs. Preece, Cardew and Rider, on payment of a deposit of £10 10s. This deposit will be refunded only upon receipt of a bona fide Tender and the return of all documents.

Additional copies of the specification may also be obtained from Messrs. Preece, Cardew and Rider upon payment of 10s. 6d. for each copy, which will not be returnable.

Tenders must be submitted in the printed envelopes provided, and all Tenders must be sealed and appropriately endorsed, and delivered to the undersigned not later than 10 a.m. on Monday, the 5th December, 1932.

The Council will not consider any Tender which does not cover the whole of the works included in the Section. The Council will also not necessarily accept the lowest or any Tender or compensate for the preparation of unsuccessful Tenders.

WILFRED TOWNEND,
Town Clerk.
Town Hall,
Fulham,
London, S.W.6.
14th November, 1932. 9165

DUST DESTRUCTOR.

The Beckenham Urban District

Council invite Engineering Firms specialising in the Design and Installation of Dust Destructor Plant to submit SCHEMES and TENDERS for (a) NEW DUST DESTRUCTOR, or (b) the RECONSTRUCTION and EXTENSION of the existing DESTRUCTOR at the Electric Generating Station, Churchfields-road, Beckenham.

Full particulars, plan and forms of Tender may be obtained on application to Mr. H. Storr Best, Surveyor, Town Hall, Beckenham, on payment of a deposit of £5 (cheque to be made payable to the Beckenham District Council), which will be refunded on the receipt of a bona fide Tender.

Schemes, endorsed "Dust Destructor," to be delivered to the undersigned not later than Noon on December 19th, 1932.

No Scheme or Tender received after the prescribed date and time will be considered, and no deposit will be returned unless a bona fide Scheme and Tender is submitted and is received by the due date and time.

The Council do not bind themselves to accept any Scheme or Tender.

By Order,
C. ERIC STADDON,
Clerk of the Council.

Town Hall,
Beckenham, Kent.
November 14th, 1932. 9172

The Engineer

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Municipal Council of Nairobi,

KENYA COLONY.

TENDERS are INVITED for the SUPPLY of MOTOR VEHICLES and EQUIPMENT suitable for Refuse Collection and Removal.

Particulars of requirements can be obtained on application from the undersigned. Tenders must be received by the Town Clerk, Nairobi, before 16th January, 1933. The Council do not bind themselves to accept the lowest or any Tender.

CARTERS (MERCHANTS), Ltd.,
39/41, New Broad-street,
9168 London, E.C.2.

Tyne Improvement Commission.

ONE 3-TON ELECTRIC CRANE.

The Tyne Improvement Commissioners are prepared to receive TENDERS for ONE 3-TON ALL-ELECTRIC TRAVELLING PORTAL LEVEL LUFFING CRANE for the Tyne Commission Quay, Albert Edward Dock, Percy Main, North Shields.

Copies of the form of Tender, conditions of contract, and specification may be obtained on and after the 16th November, 1932, on application to the undersigned on payment of a deposit of £1 1s., which sum will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes endorsed "Tender for Electric Crane," and addressed "The Chairman, Tyne Improvement Commission, Newcastle-upon-Tyne," must be delivered at the undermentioned offices not later than 9 a.m. on Monday, the 28th November, 1932.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.

Tyne Improvement Commission Offices,
Bewick-street,
Newcastle-upon-Tyne.
9th November, 1932. 9166

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THE PROPRIETOR of the PATENT No. 246,826, for "Improvement in Brakes," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., 28, Southampton-buildings, Chancery-lane, London, W.C.2. 9183 H

THE PROPRIETOR of BRITISH PATENT No. 239,080, dated November 18th, 1924, relating to "Tampers and like Impact Tools," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Illinois. 9159 H

PATENTS.—"IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF FINNED TUBING."

THE PROPRIETORS of Mr. Harry Warren Bundy's BRITISH PATENT No. 289,430 are DESIROUS of LICENSING the PATENT to British Manufacturers, to ensure its use and development, or of SELLING the PATENT outright.

For full information address inquiries to W. P. THOMPSON and CO., Chartered Patent and Trade Mark Agents, 12, Church-street, Liverpool. P3001 H

THE PROPRIETOR of BRITISH PATENT No. 321,062, dated November 1, 1928, relating to "Method of and Means for Making Apertured Blanks," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Illinois. 9143 H

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

A Heavy-Oil Aero Engine.

Some time ago the Air Ministry initiated an attempt to convert the Rolls Royce "Condor" petrol engine to the compression ignition system, and the work was performed at the Royal Aircraft Establishment at Farnborough, with the co-operation of Rolls Royce, Ltd., Compression-ignition engines have usually been designed with a substantial increase in strength and weight in anticipation of increased stresses, but in the case of the "Condor" the problem was approached from a different angle. It was ascertained how much increased strength it was necessary to add to an existing petrol engine to secure completion of the normal type test requirements for civil use when employing heavy oil as a fuel. The converted engine, we learn, has now completed this test, the duration of which is fifty hours, and is now being subjected to experimental flight tests in a Horsley aircraft, with a view to exploring the problems of the operation of C.I. engines in flight, including the effects of high altitude and low temperatures. It is hoped also to establish by practical test the theoretical advantages of low fuel consumption and cost under cruising conditions, and to find out the extent to which the size of the radiator and the weight of the cooling water may be reduced, as compared with standard petrol engines. The converted engine has a weight of 1504 lb., and develops 480 B.H.P. at normal charge and 1900 r.p.m., or 500 B.H.P. at maximum charge at the same speed. It has a length of 74½in., a width of 30½in., and a height of 45½in.; the number of cylinders is twelve, arranged in two banks, and it runs on the four-stroke cycle. With the exception of the Beardmore "Tornado" installed on the airship "R 101," which had a considerably higher weight-to-power ratio, the Rolls-Royce converted "Condor" is the only oil engine to complete the normal type test in this country.

Civil Aviation.

The Federation of British Industries sent a letter to the Secretary of State for Air at the end of last week, abstracts from which are printed below. The Federation of British Industries has noticed with great concern the statements which have recently appeared with regard to the possibility of civil aviation being internationalised. The Federation is not officially aware of the policy of His Majesty's Government with regard to this matter, and it may be that the apprehension felt is unjustified by the facts. The Executive Committee of the Federation, at its meeting on November 10th, expressed the earnest hope that no policy would be agreed to by His Majesty's Government which would in any way impede the free development of air transport upon a national and Imperial basis. Both in regard to operation and equipment no obstacles should be placed in the way of British enterprise. Control by an international body could only have the effect of sterilising the industry, stopping progress, and preventing the free play of British inventive genius and organisation. Great Britain would no longer be free to develop the air routes of the Empire in the way best suited to its needs. Design would be hampered, and the future leadership in aviation would fall into the hands of any industrial country or countries which were not bound by the proposed international regulation, but which were at liberty to develop aviation with sole regard to technical and commercial considerations.

European Syndicate of Public Works.

When the French perceived that the existing commercial treaty with Germany was working to their detriment, they sent a trade commission to that country to discuss with German commercial and industrial representatives the ways and means of replacing the treaty by some more acceptable arrangement. The announcement then made that the negotiations would not be harmful to the interests of other countries suggested that the Franco-German commissions would survey the economic situation as a whole, and the first result of the discussions is a statement from Berlin that they have approved of a plan prepared by the fourth sub-commission, whereby a European Syndicate of Public Works will be formed, comprising contractors and financiers in Great Britain, France and Germany. The President of the syndicate will be a Frenchman, and the headquarters will be in Paris. The object of the syndicate is to finance, organise and execute international public works outside the three countries named, which will provide the capital and plant and machinery necessary for the undertakings in the proportion of 40 per cent. each for Great Britain and France, and 20 per cent. for Germany. The labour will be supplied by the countries in which the works are carried out, so that they will profit from the employment given as well as from an economic equipment in the form of railway and other works. Nothing will be undertaken unless there appears to be a certainty that the capital will bring in an adequate return, and it is stated, for example, that 7000 kiloms. of railway can be electrified at a cost of about 17,000 million francs under conditions that will be beneficial to the countries concerned, as well as profitable to the groups of financiers and public works contractors in the three countries forming the syndicate. Only the main lines of the plan have been drawn up, and the details will be worked out at meetings of the sub-commission to be held in February next.

The Olympic.

Exaggerated reports have appeared in the non-technical Press relating to the condition of the "Olympic's" machinery, in view of which it is gratifying to know that the renewals and repairs now to be carried out by Harland and Wolff, Ltd., at their Southampton works will render the vessel fit for a further lengthy period in the North Atlantic express passenger service. The "Olympic" has been in service for over twenty-one years, and her machinery, which constituted an outstanding development of the reciprocating and exhaust turbine combination, has very fully realised the anticipated economy associated with that arrangement. It is interesting to recall that her two four-cylinder triple-expansion reciprocating engines are the largest ever built to work in conjunction with an exhaust turbine. The arrangement of the four cylinders, reading from aft to forward, is L.P., M.P., H.P., and L.P., the valve casings for the M.P. and H.P. cylinders being adjacent and between these cylinders. When the main bearings were being adjusted in the ordinary course, prior to the vessel's sailing last month, a fatigue crack was found in the long journal of the after crank of the port high-pressure cylinder. Further careful examination revealed two other fatigue cracks, one in the long journal of the port intermediate-pressure cylinder and the other in the long journal of the starboard high-pressure cylinder. It was necessary that the defective parts of the crank shaft should be renewed before the vessel could sail again, and on full consideration, in view of their age and continued service, it was considered prudent entirely to renew the two main crank shafts. In addition to fitting new crank shafts, opportunity will be taken to reinforce the foundations. The work now arranged, which it is expected will be completed in about three months' time, will, it is confidently expected, put the machinery and the ship in a condition to render many years of further useful service in the fleet of the White Star Line.

Industrial Delegations to Denmark.

The announcement is made by Lieut.-Colonel John Colville, the Secretary of the Department of Overseas Trade, that, following upon the British Exhibition at Copenhagen, it has been arranged by the National Federation of Iron and Steel Manufacturers that a delegation representative of the iron and steel industry will, at the invitation of Danish industrial interests, visit Denmark in order to have discussions with Danish purchasers. The *personnel* of the delegation, which will arrive in Denmark towards the end of this month, and will also visit Sweden and Norway, for discussions with iron and steel interests in those countries, is as follows:—Mr. F. C. Fairholme, Chairman, Vice-president of the Federation of British Industries, representing Sheffield industries; Mr. T. I. Piggott, representing heavy steel; Mr. J. H. Pearce, representing galvanised sheets; Mr. G. Burton Stewart, representing tubes, and Mr. C. R. Knaggs, representing pig iron. A representative of the wire and wire products industries may be added to the delegation. The same announcement states that after a discussion with Mr. Ernest Brown, the Secretary of Mines, a delegation representing the United Kingdom coal industry, both owners and exporters, and headed by Mr. Evan Williams, President of the Mining Association, will also visit Denmark for discussions with Danish coal interests. There is also to be a further delegation representative of the cattle food trades and oil extracting industries. All delegations will arrive in Denmark towards the end of November.

Belgium and Imperial Airways.

The Belgian Government has been placed in a dilemma through the failure of the French Government to fulfil its obligations to co-operate in the running of an air service between Brussels and the Congo, and eventually to Madagascar. Each country was to have formed a company financed and controlled by the State, and the French were to have arranged a route across the Sahara desert, but while they have not succeeded in this task, the Belgians had organised their participation and procured the machines necessary to start the service at the beginning of last month. The French are still exploring the Sahara desert with a view to mapping out a safe route. It cannot be foreseen when they will be able to complete it, or whether, even, such an air route is feasible, and the Belgians, therefore, thought of running the service themselves along the West Coast of Africa. Evidently, this offers great difficulties, for it is now suggested that there is no reason after all for going to the expense of organising an air route to the Belgian Congo when there already exists the line from Cairo to the Cape, which skirts the eastern border of the Belgian territory. The British line, it is argued, is running and is reliable, and therefore offers advantages to the Belgians, who may be tempted to utilise it for their Colonial service. It is certain, however, that the French will not forego their plans if they find it possible to negotiate the Sahara desert commercially with aeroplanes, for they must have their direct route to Madagascar, which is only possible by crossing the Belgian Congo.

Proposed Bridge at Finnieston.

At a meeting of the Corporation of Glasgow Cross-River Communication Committee, which was held on Friday last, November 11th, it was decided to revive the scheme for constructing a high-level bridge over the Clyde at Finnieston, which was adjourned by the Corporation in July last. After reviewing the cost of temporary accommodation, should the Clyde Navigation Trustees require the removal of the existing Finnieston ferry in order to operate the new 175-ton fitting-out crane, it was decided to recommend that the Corporation reconsider the bridge scheme, and to approach the Clyde Navigation Trustees with a view to a less clearance under the bridge than 76ft. being adopted. The Committee also recommended the Corporation to consider and report on the modifications suggested by Mr. T. P. M. Somers, M. Inst. C.E., the Master of Works, with a view to lessening the cost of the proposed bridge. These modifications include the lessening of the width of the bridge from 70ft. to 64ft., a new scheme of loading without provision for exceptionally heavy loads, and modified approaches and gradients. The Corporation is also requested to report fully as to the expediency and practicability of utilising the Harbour Tunnel for quay-to-quay traffic, and the improvements which it will be necessary to make in the tunnel and its lifts in order to fit it for such a purpose.

A Railway Appointment.

The London, Midland and Scottish Railway Company announces the appointment of Mr. D. C. Urie, M. Inst. C.E., mechanical engineer for the Northern Division, as superintendent of motive power, with headquarters at Derby. Mr. Urie, who will take up his duties almost immediately, succeeds Mr. J. E. Anderson. He brings to his new appointment a wide railway experience in England, Scotland and Ireland. Mr. Urie was born in 1884, and received his training under his father, Mr. R. W. Urie, the late chief mechanical engineer of the London and South-Western Railway. After extended experience on that railway, on the Midland Great Western Railway of Ireland, and on the Highland Railway, Mr. Urie was called upon to take a prominent part in the reorganisation of the L.M.S. Railway shops in Scotland. On the grouping of the railways in 1923, he was made assistant mechanical engineer of the Northern Division at Glasgow, being later promoted to divisional mechanical engineer.

The High Level Bridge, Newcastle.

On the two last Sundays, November 6th and 13th, the engineers of the London and North-Eastern Railway were engaged on renewing the heavy timber work under one of the tracks across the High Level Bridge, at Newcastle-upon-Tyne. The railways over the bridge consist of three lines of way, of which two are used for inward and one for outward traffic. The rails are of heavy flat-bottomed type, resting on a steel plate, and are screwed down on to longitudinal beams of timber measuring 14in. wide by 10in. deep. These, in turn, rest on cross beams laid on top of the continuous decking of the bridge. In order to reduce the crushing effect of heavy loads, steel plates are introduced between the longitudinal and the cross timber, and accuracy of level is secured by steel packing of varying thicknesses, electrically welded to the plates where necessary. The renewal becomes necessary on account of the normal decay of the timber. As one track had to be entirely dismantled, and a second was required for a train load of new material, as well as a considerable rake of wagons to receive the old, whilst a third track was required for the activities of two steam cranes, there was no other course than to hand over the bridge for the operations of the engineers. This occupation was limited to between midnight and 6 p.m. on each Sunday, when all traffic was diverted *vid* the King Edward Bridge. The last train to reach the bridge was the 11.59 from Newcastle on Saturday night, and one minute later the engineers' special train was on the site. Two shifts of about forty men were required to complete in the time allotted, whilst some 2000 cubic feet of timber represented the main material required. Lighting was provided by a string of acetylene lamps across the length of the bridge, and the work was expedited as far as possible by the use of pneumatic tools. Everything was carried through according to schedule, and the first train to use the bridge was the 5.35 from Newcastle to South Shields on Sunday evening.

Standard Pitot-Static Tube Calibration at Low Air Speeds.

By E. OWER, B.Sc., and F. C. JOHANSEN, M.Sc.

The Standard Anemometer.

Under normal engineering conditions, the determination of the speed of moving air by direct measurement in terms of units of length and time has so far proved impracticable, and the engineer is accordingly obliged to resort to the use of instruments whose action depends on some physical effect characteristic of the motion of air. All such instruments, or anemometers, consequently, serve to measure air flow indirectly, and the relation between the magnitude of the effect employed, whatever it may be, and the speed and condition of the air to which it is due, has ultimately to be determined by experimental calibration. It follows that, whilst a type of anemometer may be satisfactorily sensitive in indicating the physical effects of varying air speed, its practical utility is largely to be appraised by the degree to which its calibration, once determined, remains unaltered over long periods of time. In the case of an anemometer intended for service as a standard, on account of the difficulty and expense incurred by a precise fundamental calibration, this aspect of permanence assumes very great importance in relation to which it is pertinent to examine briefly the characteristic qualities of the three basic types of anemometer at present in common use. In what may be termed mechanical anemometers the motion of the air serves to deflect a hinged vane, or to rotate a windmill. To ensure sensitivity at low speeds, such instruments are usually of delicate construction and are susceptible, in consequence, to structural damage or distortion of an unobstrusive nature. Moreover, their operation involves moving parts, so that mechanical friction is included among the factors which influence their indications, and leads in time to uncertainty as regards the constancy of calibration. It is a matter of experience, indeed, that windmill anemometers require fairly frequent calibration and, even with most careful treatment, may exhibit appreciable changes of performance. Whilst extremely convenient for many practical purposes, therefore, they are unsuitable for maintenance as primary standards. Even greater variations of calibration factor are found to be the principal objection to hot wire anemometers, in which the rate of heat loss from an electrically heated wire mounted in an air stream serves to measure the speed of flow. For laboratory work, especially in connection with very low air speeds, hot-wire instruments offer many advantages, notably a high degree of sensitivity and a minimum of interference with the air stream under observation. On the other hand, they are necessarily fragile instruments and their operation calls for somewhat delicate auxiliary apparatus. One further point, which applies both to mechanical and hot-wire anemometers, is the absence of any reasonable certainty that two instruments, made as far as possible identical, will respond exactly alike to air speed.

All such defects are largely obviated in pressure anemometers, which depend for their action on the pressures exerted by moving air on a body of suitable shape exposed in the stream. This type of instrument, having no moving parts, is free from mechanical friction; further, it is capable as a rule of robust construction, and its calibration, solely dependent on shape, is at once invariable and, to a high degree of accuracy, the same for geometrically identical instruments. It is not surprising, therefore, that the combined pitot-static tube—one of the most convenient forms of pressure anemometer—has been generally accepted for standard purposes. Moreover, once a particular design has been calibrated, geometrical replicas can be confidently employed for actual air speed measurements without individual calibration. The standard pattern in use in Great Britain, shown in Fig. 1, is too well known to need detailed description. It is sufficient to mention that it consists essentially of two tubes arranged coaxially, one of which, the open-ended facing tube A, measures the total head of the air current, whilst the annular tube B, furnished with a number of holes C, serves to measure the static pressure. The difference between the pressures registered by the two tubes is, therefore, a function of air speed, and is observed in practice by means of a differential manometer to the opposite limbs of which the anemometer tubes are connected.

The statement that the pitot tube of the instrument registers total head is accurately supported by experiment, being true irrespective of the shape of the tube within wide limits. In a well-designed instrument static pressure is also registered with good accuracy, but it may be said, in general, that this side of the instrument is imperfect to a degree which varies with the speed of the air stream. Any error so introduced may be represented by a calibration factor K in the relation between differential pressure P, speed V, and mass density ρ*, which can thus be written in the form:

$$P = K \cdot \tfrac{1}{2} \rho V^2 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Usually the error is small, so that K is nearly unity. This, however, is incidental, the more important point being that K, once determined for a particular instrument by direct calibration, may be relied on to persist throughout the useful life of the instrument and to be affected by nothing short of mechanical damage of a kind that can be readily detected by visual inspection and leak testing.

In the year 1912, the type of pitot-static tube shown in Fig. 1 was carefully calibrated on a whirling arm at the National Physical Laboratory at air speeds between 20ft. and 60ft. per second. Over this range of air speed the value of the factor K was found to be unity, to an accuracy of about 0·1 per cent., and subsequent experiments in water showed that this value could be taken to hold good up to rates of flow equivalent to air speeds of about 250ft. per second. In view of the satisfactory performance of this instrument, it has been adopted as the National Physical Laboratory Standard for the measurement of air speed.

The calibration of 1912 was not carried below 20ft. per second, mainly on account of the serious experimental difficulties experienced with the available apparatus in measuring the very small velocity pressures equivalent to low speeds. At that time the Laboratory experienced little demand for a standard instrument to measure speeds below 20ft. per second, and no attempt was made to extend the calibration range. In later years, however, an increasing number of requests was received at the Laboratory for calibrations of low-speed anemometers. For some time these instruments were calibrated either directly on the whirling arm, or in a wind tunnel by reference to a specially designed low-speed vane anemometer, which itself had to be recalibrated on the arm at regular intervals. But as the demand for low-speed calibrations increased, it became evident that a great saving of time would result if the value of the pitot-static factor K could be established at low speeds. For it would then be possible to calibrate low-speed anemometers by the much more convenient and rapid method employed for higher speed instruments, namely, by placing them in a wind tunnel and observing their readings at a series of wind speeds measured by means of the standard pitot-static tube. It was, therefore, decided to extend the calibration of the standard pitot-static tube to as low a speed as possible.

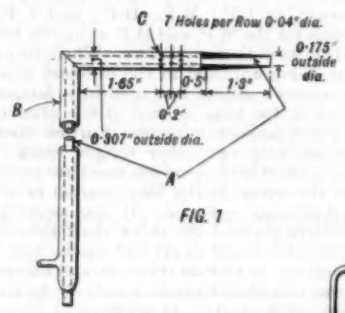


FIG. 1

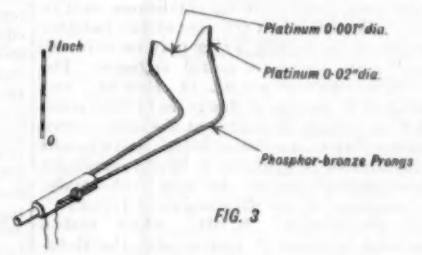


FIG. 3

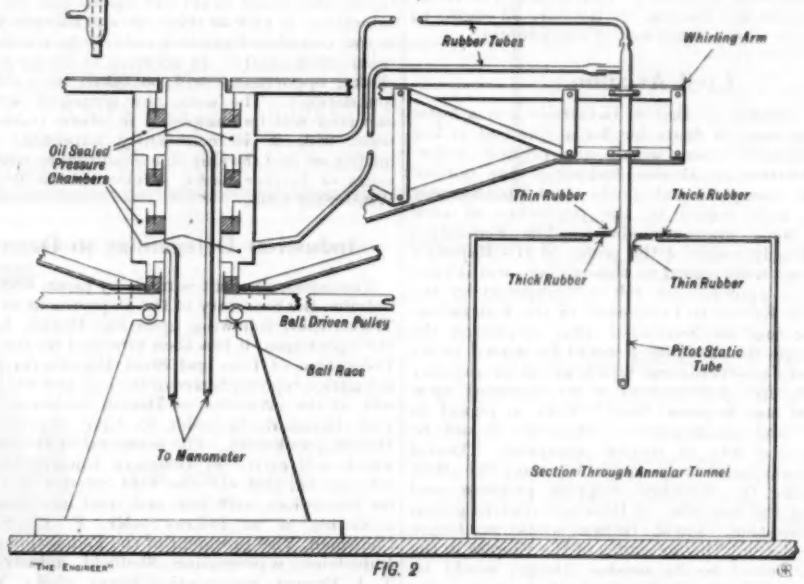


FIG. 2

Development of Experimental Procedure and Apparatus.

The ideal method of conducting a fundamental calibration of the instrument would be to cause it to move in a straight path at known speeds through still air, and to observe the values of the differential pressure P. The factor K could then be calculated from equation (1), since V would be known. Grave objections to this method arise, however, on the scores both of expense and experimental difficulty. A method was accordingly adopted similar to that previously employed for calibrations at the higher speeds at the N.P.L. and elsewhere. Here the pitot-static tube is mounted on the end of an arm rotating about a central axis, generally vertical, so that the instrument travels in a closed circular path at a measurable speed relative to the ground. Unfortunately, this speed is not the same as the speed through the air, for the motion sets up a rotary movement or "swirl" of the air, and the true air speed is the difference between the ground speed and the swirl speed. In the accurate measurement of the swirl speed lies the major difficulty of all calibrations on a whirling arm. As a rule, the swirl speed is only a small percentage of the ground speed, and is therefore low and not easily measured. The difficulties in the present instance were intensified on account of the low range of speeds for which the calibration of the pitot was sought, and a number of experimental arrangements was tried before a satisfactory scheme was evolved.

In the first arrangement the pitot-static tube was mounted at the end of an arm of about 4ft. radius, which was rotated about a vertical axis through belt and pulley gearing by means of an electric motor. A double liquid seal, adapted from an old seal taken from the large whirling arm at the N.P.L., was mounted on the axis and served to transmit the pitot and static pressures to be measured from the moving instrument to the stationary manometer. The whole apparatus was installed in a room about 25ft. square, and the path of the pitot was screened as far as possible from disturbances caused by the rotating arm, so that the swirl in which the pitot moved was practically only that due to the instrument itself. Preliminary experiments with the linear speed of the pitot greater than 20ft. per second, for which the value of K was known from the calibration of 1912 to be unity, showed that the swirl at these speeds was about 0·75 per cent. of the ground speed.

Attempts were made to eliminate this swirl, but it was found impossible to effect any perceptible reduction in its magnitude, either by rotating a dummy pitot in the opposite sense to that of the instrument itself and at the same speed, with the two orbits only about an inch apart; or by inserting eight baffles in the path of the pitot with slits in them only just wide enough to allow the instrument to pass through without fouling. It seemed that with the path of the pitot not enclosed in any way, the major part of the swirl was confined to a narrow band of little greater width than the diameter of the tube. It was also found impossible to measure the swirl by means of a sensitive hot-wire anemometer, since the natural draughts in the room more than masked any galvanometer deflections due to the low swirl speed. As a final resort, it was decided to try the expedient of measuring the pitot-static pressure at any constant arm speed when three, two, and one dummy pitot tubes were successively introduced into the orbit, each at the same radius as the pitot itself. In this way, presumably, the differential pressure set up by the motion could be observed in the swirls of four, three, two, and one instruments, and it was hoped that it would be possible to determine by extrapolation the pressure difference corresponding to zero swirl.

Before this scheme could be properly tried out, however, it became evident that the apparatus in its existing—somewhat crude—form would not give the desired accuracy. Two design features in par-

* ρ = weight/volume × gravitational constant.

ticular were shown to be essential. First, the construction of the liquid seal must be such as to prevent the volume of air contained by it from changing as a result of relative motion between the fixed and moving parts. This condition was not fulfilled in the adapted seal first used. Neither were the various parts accurately turned concentrically with the central axis, with the result that a disturbing pumping action occurred, synchronous in period with the rotational speed of the arm, and rendered the observations of mean pressure insufficiently accurate. Secondly, it appeared essential to enclose the path of the pitot as completely as possible, since the natural draughts in the room, even with closed door and windows, were often strong enough to affect seriously the readings at low speeds.

As a result of the experience gained during these preliminary experiments, the apparatus finally used for the calibration was designed. The path of the pitot was now enclosed in an annular wooden tunnel of 2ft. square section, and about 50in. mean radius. The pitot protruded vertically downwards into the tunnel, through an annular slit in the roof at the mean radius, the slit being sealed all round except at the point of entry of the pitot by means of a rubber joint, lubricated with glycerine to allow of the easy passage of the pitot through it. Outside the tunnel the pitot was attached to an arm, whose inner end was anchored to the outer rotating portion of the specially designed liquid seal which served to transmit the total head and static pressures to the manometer. The essential features of this seal are shown in the general arrangement diagram of Fig. 2. The drive, as before, consisted of an electric motor and a belt and pulley system. The total-head and static tubes of the pitot were connected to the liquid seal by means of rubber tubing tied to the radial arm carrying the pitot, while connection between the seal and the manometer was made by means of two other lengths of rubber tubing passing underneath the tunnel. A single lead pipe enclosed the two latter tubes in order to equalise as far as possible the temperature of the air within them, and so to avoid any pressure differences due to the presence of vertical columns of air of unequal temperature on the two sides of the manometer.

Steadiness and constancy of the arm speed during a run were essential for the realisation of the desired order of accuracy of pressure measurement. The motor was run from a large battery, the regulation normally employed consisting of a potentiometer supply to the armature and a rheostat in series with the field. For fine regulation a carbon pile in the armature circuit was found most effective. In order to enable any change in speed of the driving motor during a run to be detected instantaneously and corrected, a continuous speed indicator was essential, and as no instrument of the desired sensitivity—at least 0·1 per cent. over a fairly wide speed range—was available, a simple, but effective apparatus was designed. It consisted of a permanent horse-shoe magnet driven through a claw coupling by the motor shaft. Between the limbs of the magnet was a fixed coil of a large number of turns of fine wire wound on a soft iron core. The alternating E.M.F. generated in this coil by the rotation of the magnet was led to a reflecting mirror A.C. dynamometer, consisting of a fixed and a moving coil in series. The deflection of the latter was observed in the usual way by means of a lamp and mirror producing a spot of light on a scale. Any change in motor speed was instantly apparent from a deflection of the spot of light, and was corrected by operation of the control. This arrangement proved extremely sensitive to small changes of motor speed over the whole speed range, but it was used only as an indicator to ensure constancy of speed. The actual speed of the pitot over the ground was measured by means of electric spring contacts on the arm and the tunnel, the circuit being closed by the passage of the arm every quarter revolution, and operating a recording chronograph. At low speeds, however, below about 5ft. per second, the spring contacts tended to impair the regularity of revolution, and it was found preferable to remove them and to measure the rotational speed of the arm by direct timing with a stop watch.

Two different manometers were used for the calibration, one for speeds above about 15ft. per second and the other for lower speeds. The former was a 13in. Chattock gauge of the ordinary type, although somewhat improved in mechanical details. With its aid a velocity head corresponding to a speed of 15ft. per second could be read to an accuracy of about 0·25 per cent., while at 24ft. per second the accuracy was 0·1 per cent. For the lower speeds a new type of manometer was designed, which responded to a differential head of less than 0·00001in. of water and was thus more than ten times as sensitive as the Chattock. It enabled an accuracy on pressure measurement of well within 0·1 per cent. to be achieved at 15ft. per second, while at 2ft. per second the accuracy was ±1·0 per cent. A full description of this instrument has been published elsewhere.†

Range of Calibration and Details of Experiments.

The pitot-static tube was calibrated over a range of true air speed from about 1·6ft. to 23·8ft. per second. The upper limit was set by the fact that the apparatus was not suited to run at higher speeds for long periods, and as this speed provided a definite overlap with the calibration of 1912, and agreement was found (see below), no purpose would have been served by carrying the work to higher speeds. As regards the lower limit, this was fixed by the fact that even with the new sensitive manometer the accuracy on the pressure measurement would not have been good enough at lower speeds. Moreover, the accuracy on swirl, as will be mentioned later, deteriorated as the test speed was reduced.

For the purpose of the tests the pitot was set up in the tunnel with its stem vertical and its head horizontal and tangential to the circular path at the central row of static holes. The radius of the path, measured to the axis of the head at this point was about 50in., and since the mouth of the total-head tube is about 2in. forward of the central row of static holes, it follows that there was a local yaw of about 2¼ deg. at the mouth of the total-head tube when the instrument was in motion. Tests showed, however, that if the setting was slightly altered by about this angular amount no difference could be detected in the pressure observed at a given translational speed. It is known, too, that the total head tube registers correctly up to at least 10 deg. yaw.‡ Hence the small local yaw present during the calibration produced no error. Another possible source of error resulted from the setting, namely, the slight difference between the distances from the centre of rotation to the axis of the head at the static holes and at the mouth, can be shown to be negligibly small—about 0·01 per cent., in fact. The small deflection of the pitot-static head under centrifugal force was directly measured, the increased radius of revolution being taken into account in the computation of speed relative to earth.

The procedure followed in taking an observation was designed to prevent the possibility of pressures set up in the system by the rotation of the oil-sealed chambers from influencing the final result. The arm was set in motion at approximately the desired speed, controlled at a steady rate by the aid of the electrical indicator described above, and allowed to make a sufficient number of revolutions for the swirl to become established at its final value. The differential pressure across the two sides of the pitot-static tube was then measured on the manometer, and simultaneously the speed of the arm was either recorded chronographically or observed by the aid of a stop-watch, the duration of the observations being long enough to enable the speed of the pitot tube relative to earth to be determined well within 0·1 per cent. The connections from the rotary seals to the pitot and static sides of the instrument were then interchanged and the observations repeated at closely the same rate of whirling arm revolution. Owing to their design and careful construction, no systematic effect arising from the rotation of the seals was, in fact, observed, but the practice of interchanging the connections was continued throughout the research, providing both a safeguard against unforeseen contingencies and a means of obtaining at each speed two independent results which served to check one another.

After the two sets of observations at each speed had been completed, wet and dry bulb temperatures of the air were noted. For this purpose the wet and dry bulb thermometers were inserted in a length of 2½in. diameter pipe communicating with the inside of the tunnel, and air was sucked from the tunnel through this pipe by means of a small fan. From a knowledge of these temperatures and of the barometric pressure, which was observed with the aid of a standard barometer, the value of the air density ρ was calculated, due allowance being made for humidity.

Measurement of the Swirl.

The order of accuracy aimed at in the investigation was about 0·1 per cent. on any individual observation. No difficulty was found in realising this accuracy on the measurement of speed relative to the ground down to the lowest values, although on pressure it could not be maintained below about 7ft. per second. It will be clear, therefore, that the accuracy of the final calibration hinged largely upon the precision of the swirl determination, and this presented perhaps the most troublesome problem of the whole investigation. Very little work was necessary to show that the results given by the method, mentioned above, involving the use of a variable number of dummies, fell far short of the desired accuracy, and this expedient was therefore abandoned at an early stage in favour of a more direct method. At first it appeared possible that a method involving the use of the total-head tube itself could be used, for it was known from other work§ that this tube read accurately down to very low air speeds. In trial, however, this method proved impracticable, and the use of hot wire anemometers fixed in the tunnel and acted upon by the swirl was finally decided upon. Owing to the fact that the path of the pitot was now totally enclosed the disturbing effect of natural draughts, which had prevented the use of the hot wire anemometers in the early experiments, was almost entirely absent.

Several hot wire anemometers were made up and used during the calibration. A typical example is shown in Fig. 3. The heated elements were platinum wires, 0·001in. or 0·002in. in diameter, and about 0·75in. long. When in use the wire was kept at constant temperature, *i.e.*, at constant resistance, by reference to the galvanometer of a Wheatstone bridge circuit, in one arm of which the wire was included. The current through the wire had to be adjusted to a value depending on the swirl speed past it in order to keep the resistance of the wire constant. Hence, each swirl speed corresponded to a definite potential drop across the wire. This was measured by means of a standard potentiometer and, once the wire had been calibrated, enabled the swirl speed to be deduced.

For the calibration of each wire the tunnel itself was used, the wire being attached to the rotating arm and moved through the still air inside the tunnel at known speeds covering the swirl range, a potentiometer reading being taken at each speed. It may be mentioned that no brushes or slip rings were used to connect the moving wire to the stationary electrical instruments. Ordinary direct wire connections were used, the wires being of sufficient length to allow adequate movement for the calibration. At intervals the wires were disconnected and untwisted.

After a wire had been calibrated it was removed from the arm and mounted in the tunnel so that it came as close as possible to the actual path of the pitot-head. The smallest clearance between the wire and the head as it passed was rather less than 0·05in. Tests carried out to find whether, provided the wire was reasonably close to the path, there was any difference between the swirls as measured by the wire in different attitudes with respect to the head, failed to reveal any such difference whether the wire was vertical or horizontal. A slight increase in clearance also produced no measurable change. In most cases the wire was bent into a shallow open loop, whose two ends were in an approximately horizontal line perpendicular to the path of the pitot.

When the calibrated wire had been adjusted in position in the tunnel, a series of potentiometer readings was taken for different measured speeds of the pitot over the ground, and, by reference to the previously established hot-wire calibration curve, these potentiometer readings could be translated into swirl speeds. It should, perhaps, be mentioned that no reading of the swirl was taken before at least 150 revolutions of the arm had been completed, for it was found that about this number of revolutions was required for the swirl to build up to a steady value as evidenced by a steady potentiometer reading.

It is not possible here to describe the numerous difficulties encountered in the calibration of the hot wires and in their use to measure the swirl, nor of the various expedients by which these difficulties were overcome. The final accuracy on swirl is, however, regarded as quite satisfactory. Three separate determinations were made at different times, and they all agreed excellently. The swirl speed varied from 6·5 per cent. of the ground speed of the pitot at a ground speed of 2ft. per second to 7 per cent. at 12ft. per second, and about 8·5 per cent. at 24ft. per second. The lowest value of the swirl actually measured was 0·113ft. per second (1·73ft. per second ground speed), and the accuracy here is estimated to be about 3 per cent. Hence, the accuracy on the true air speed is about 0·2 per cent. (3 per cent. of 6·5 approximately). At the highest speeds of the range the swirl is thought to be accurate to well within 1 per cent., so that the accuracy on air speed is better than 0·1 per cent.

Results Obtained.

The following table gives the mean values of K* as deduced from smooth curves through the plotted points representing the observations :—

Mean Values of K for Standard Pitot-static Tube.

Air speed V (feet per second). Air at 15·6 deg. Cent. and 760 mm. Hg. (ρ = 0·00237) slugs/ft.³.	$K = P/\frac{1}{2}\rho V^2$.
2	1·020
4	0·989
6	0·995
8	0·992
10	0·991
12	0·992
14	0·995
16	0·998
18	0·999
20	1·000
22	1·001
24	1·001

It will be seen that the values at speeds in the neighbourhood of 20ft. per second agree excellently with the value of unity established by the 1912 calibration on the large whirling arm. Below 20ft. per second K decreases somewhat to a minimum value at 10ft. per second. As the speed falls further, the value of K fluctuates slightly, but between 4ft. and 2ft. per second there is a sudden sharp increase in K, which, from the appearance of the curve, would probably have been found to persist had the calibration been taken to still lower speeds. It should also be stated that at speeds above 14ft. per second the observed points all fell well on a single curve, whereas for the lower speeds they were distributed over a band whose width apparently increased to a maximum at just about the speed at which the sudden rise in

† "A Micromanometer of High Sensitivity," Ower, *Phil. Mag.*, X., 1930, page 544.

‡ See *Aer. Res. Comm. Reports and Memoranda*, No. 445: "The Design of a Sensitive Yawmeter," Pannell and Jones.

§ "Proc.," Roy. Soc. A., Vol. 101, page 435 (1922).

* The factor K is the reciprocal of the factor K given in the full account of the work that has been published as *Aer. Res. Comm. Reports and Memoranda*, No. 1437.

K began. There seemed, in fact, to be a region of instability between about 4ft. and 14ft. per second, with evidence that this instability would have become less at speeds below that at which the calibration ceased. At 14ft. per second the extreme values of K were just ±1 per cent. different from the mean values given in the table. The mode of variation of K appears strongly indicative of a region of transition between two different types of flow, one of which prevails at speeds above 14ft. per second, and the other seems to be about to begin at a speed rather below 2ft. per second. The phenomenon appears, in fact, markedly reminiscent of the well-known critical transitional range between the streamline and turbulent *regimés* of flow in smooth pipes.

Practical Significance of the Results.

The work has shown that the value of unity found previously to hold for the pitot-static factor K at speeds over 20ft. per second, may, for practical purposes, be taken to hold also down to a speed of about 5ft. per second. Further, since, as can be verified from equation (1), a small error on K produces only half the error on V, the assumption that K is unity at all speeds down to 3ft. per second will in no case involve an error exceeding 1 per cent. on speed, while if the actual values given in the table are used the error on speed at 3ft. per second will be within ±0·5 per cent. To make use of the tabulated values of K in the measurement of an unknown low air speed, the procedure will be to calculate the speed approximately from the observed differential pressure on the assumption that K=1, and then to substitute the true value of K corresponding to the approximate speed thus obtained and to recalculate. A second approximation will be unnecessary in view of the small variation of K.

This calibration establishes the combination of the standard pitot-static tube and a sufficiently sensitive manometer, such as that here used, as a piece of standard apparatus for the measurement of low air speeds, down to about 4ft. per second. It would not be safe to proceed further on account of the steep rise of the K–V curve that begins at this value of V. The range could be extended to 2ft. per second by using a geometrical copy of the standard tube constructed to a scale of twice the original, for it is known from the law of dynamical similarity that the sudden rise in K for such an instrument would begin at half the corresponding speed for the standard, *i.e.*, at 2ft. per second. The utility of this standard combination would, however, be restricted in practice on account of the difficulty of using the very sensitive manometer under ordinary engineering conditions. Usually, it will be found more convenient to employ other types of anemometer—the vane anemometer, for example—at low speeds, and to calibrate these, or have them calibrated in the Laboratory, against the standard combination. Such calibrations can now be carried out much more quickly, and more accurately, than was possible before the values of the pitot-static factor at low speeds had been determined.

Precision Grinding Machines.

No. IX.*

SURFACE GRINDING.

Whereas cylindrical grinding is always performed with the periphery of the wheel surface, grinding can also be done with the side. For this purpose—owing to the fact that use of the side of an ordinary wheel is not to be recommended—cup, ring, or segmental wheels are employed. The use of the periphery or the side of the wheel divides surface grinders broadly into two classes, the horizontal spindle and vertical spindle types respectively. The division is not perfect in that horizontal spindle machines using the side of the wheel and vertical spindle machines using the periphery are made. A further subdivision is brought about by the fact that the machines may be fitted either with reciprocating or rotating tables, according to the kind of work for which they are designed.

The best wheel speed for general practice is in the neighbourhood of 4000ft. per minute, and once the correct speed has been found, the margin of permissible variation is small. This fact gives the vertical spindle arrangement a very important advantage over the other, since however great the wear of the cup or similar wheels fitted to such machines, the surface speed of the wheel remains the same. When a peripheral wheel wears, the speed alters, and therefore either gears or stepped belt pulleys must be provided, so that the revolutions per minute may be increased. Another advantage enjoyed by the vertical spindle type is that the area covered for one stroke of the reciprocating or one revolution of the rotating table is limited by the diameter of the wheel, whereas on a horizontal spindle machine it is the width of the wheel, which cannot be so great as the diameter of a cup or similar wheel, which limits the area ground. Consequently, where high production is required, the vertical spindle machine is usually chosen. These disadvantages of the horizontal spindle machine are set off to a certain extent by the superior accuracy obtainable, but even on the less perfect vertical type parts may be easily ground to thickness with an accuracy of the order of 0·0005in.

The selection of suitable grinding wheels for flat grinding is a matter of some difficulty, as compared with the same problem in cylindrical grinding. Owing to the large area of work covered, cup or ring wheels must not be too hard or the heat generated cannot be removed sufficiently rapidly, and particularly when cup and ring wheels are concerned, it is necessary to supply a copious quantity of coolant. On heavy vertical spindle machines as much as 40 gallons a minute may be required, and should be delivered as to the major quantity within the cup or ring wheel, so that the chips shall be carried outwards. Any mistake as to grade can only be rectified by changing the wheel, an alteration of the speed or feed being ineffective in most cases.

For the greatest production it is necessary to run vertical machines at the highest table speed compatible with accurate grinding, while in horizontal spindle types the rate of traverse is also of some importance. For roughing, it should be made nearly equal to the width of the wheel, always provided that the machine is sufficiently powerful to maintain the wheel speed while the cut is being taken. As to finishing, the rate depends principally on the desired degree of accuracy, and the nicety of the surface required. On the majority of machines the depth of the cut has a comparatively small influence on the productive capacity. For the finest work the finishing cut may be 0·00025in., or less, while roughing cuts as great as 0·005in. may be taken on powerful machines. The difference between methods of cylindrical and surface grinding is well illustrated by a statement of the Norton Company of America that in plane surface grinding it has been found both economical and practical to use a constant work speed and to obtain proper action, either

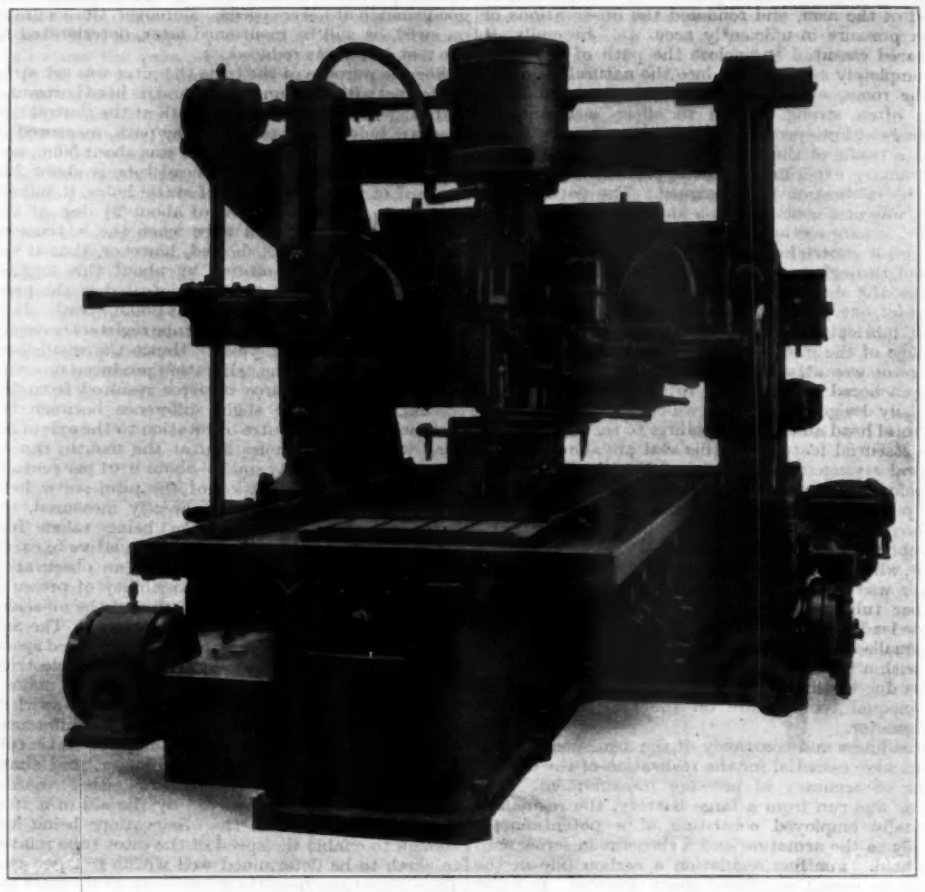


Fig. 51—Lumsden Vertical Spindle Reciprocating Table Surface Grinder

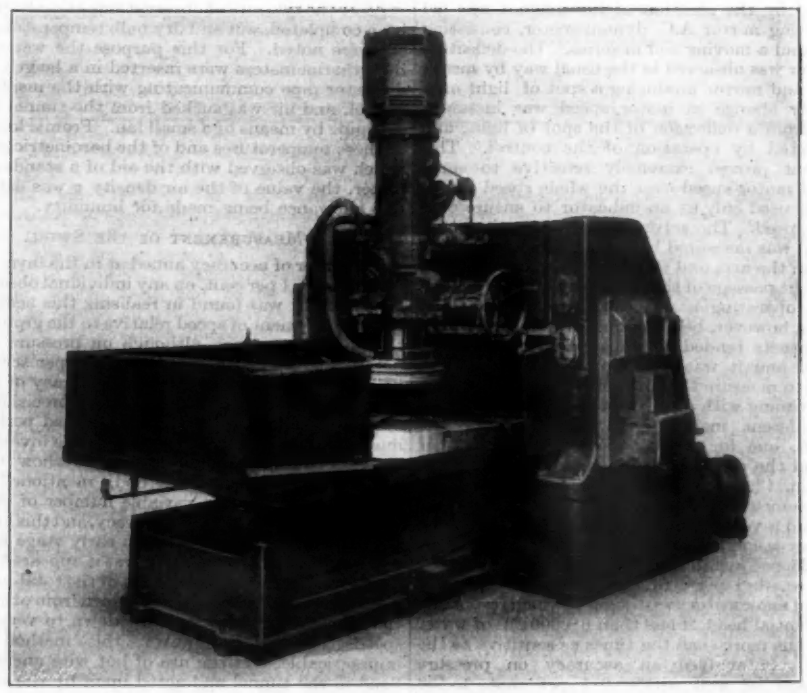


Fig. 52—Lumsden "Universal" Surface Grinder

* No. VIII. appeared November 11th.

by varying the depth of the cut or changing the wheel.

Vertical Spindle Machines.

That the design of vertical spindle, reciprocating table, surface grinders owes much to the planer is well shown by the illustration, Fig. 51, of a machine made by the Lumsden Machine Company, Ltd., of Gateshead, for which Alfred Herbert, Ltd., of Coventry, are sole agents. In addition to the reciprocating table, it is fitted with a transverse movement of the grinding head. The work can therefore be moved longitudinally beneath the grinding wheel, or the grinding wheel can be moved transversely across the work, or both these movements can be applied in sequence. Various methods of combining the two motions are possible. If, for instance, a hollow rectangular face has to be ground, the table travel and the head traverse can be set to come into action alternately, so as to cause the wheel to move uninterruptedly round the whole of the face. Alternatively, the wheel can be moved automatically in the transverse direction at each reversal of the table or transverse motions, when these are used separately, or at suitable points in the cycle, when they are combined.

The table reciprocates on one V and one flat guide in the bed, whilst the wheel head is mounted on a slide on the cross saddle, which can be raised or lowered on the supporting columns by power. The segmental grinding wheel is driven through a flexible coupling by a motor of 25 horse-power, mounted above it and fed hydraulically.

A Rotary Table Machine.

A rotating table machine constructed by the same makers is illustrated in Fig. 53. The grinding wheel consists of a rigid chuck, in which the abrasive segments are securely held by bronze wedges. As the segments wear they can be adjusted outwards, and may be used until they are less than 1in. thick. The wheel diameter is 26in. The wheel head is fixed and vertical adjustment is effected by means of a cylindrical ram. Both a hand and an automatic down feed are provided, and there is also an adjustable limit stop for grinding dead to size automatically. The ram is protected at the top and bottom against the entry of grit and moisture; it carries the wheel spindle in ball and roller bearings. In order that it shall not be possible for the ram or the spindle to drop, the spindle thrust bearings are connected to an overbalancing weight. The alignment of the wheel with the table is maintained by the use of four adjustable point supports. Coupled direct to the spindle and mounted above it is the main 40 B.H.P. vertical spigot motor running at 725 r.p.m. Beneath the table there is bolted a large phosphor bronze worm wheel engaging with a hardened and ground nickel-chrome worm mounted on ball bearings and driven at either of two speeds, selected by clutches, by a separate 3 B.H.P. motor mounted at floor level. The main gearing runs in an oil bath and the table path is force-lubricated. A supply of coolant is delivered to the wheels through two nozzles by a centrifugal pump and open channels return the water to the settling tank. The following table gives some dimensions not previously mentioned :—

Wheel, actual diameter	26in.
Segments, number of	12
Table diameter and grinding capacity	60in.
Capacity inside water guards	70in.
Takes magnetic chuck diameter	63in.
Maximum height under wheel	18in.
Minimum height under wheel	0in.
Maximum height over magnetic chuck (when supplied)	14in.
Table speeds, r.p.m.	10 and 2½
Automatic feeds, inches per minute, with automatic trip	0·03–0·00
Spindle, r.p.m.	725
Spindle motor, r.p.m.,	725
Spindle motor, B.H.P.	40

A Universal Type.

A combination or universal surfacing grinder is required for certain classes of work, and such a machine made by the Lumsden Machine Company, Ltd., of Gateshead, is illustrated in Fig. 52. It will be observed that it has both reciprocating and rotating table movements. While designed primarily for grinding dies, it lends itself to a variety of other work which cannot be dealt with conveniently on a straightforward rotary table machine. As illustrated, the tool has a fixed head, but for special purposes it is made with an elevating cross rail, which gives it a greater vertical capacity. The head may also be mounted on a cross slide. The heavy box-section bed carries the saddle which, in its turn, carries the rotary table. In contradistinction to other machines

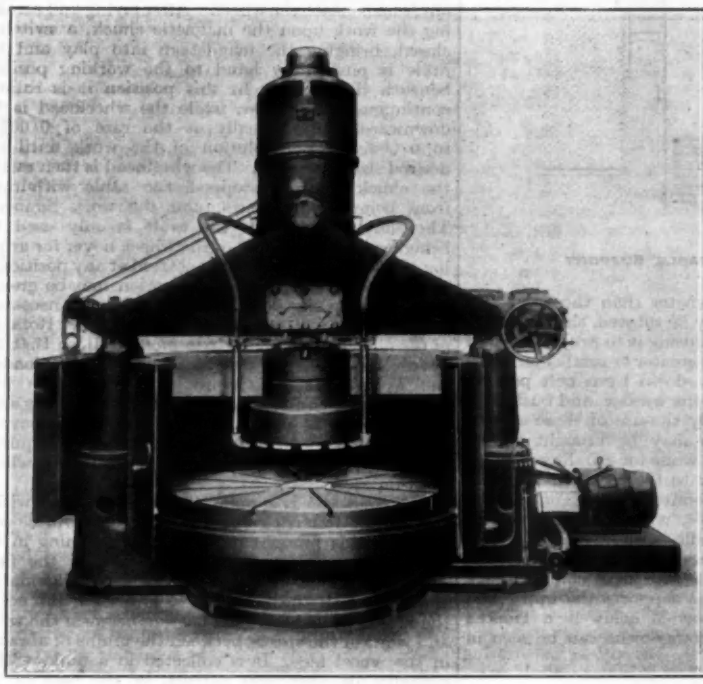


Fig. 53—Lumsden Rotary Table Grinder

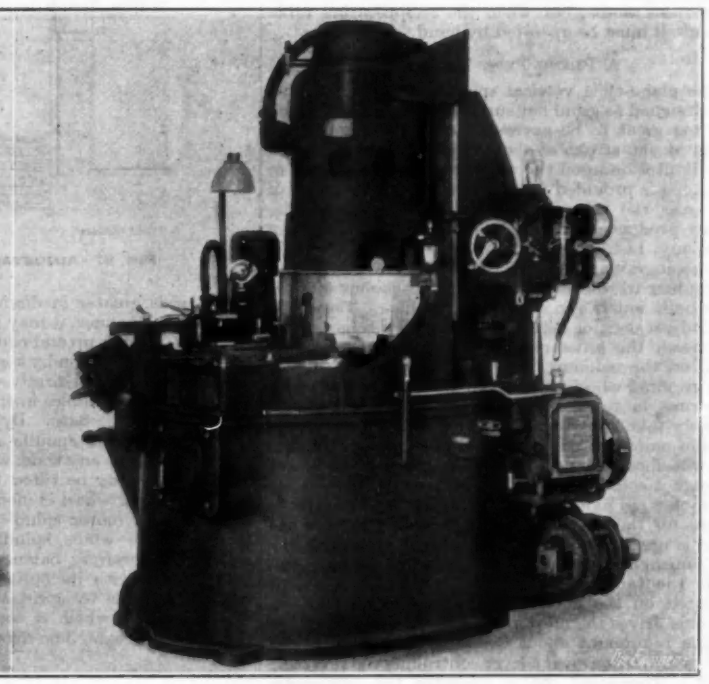
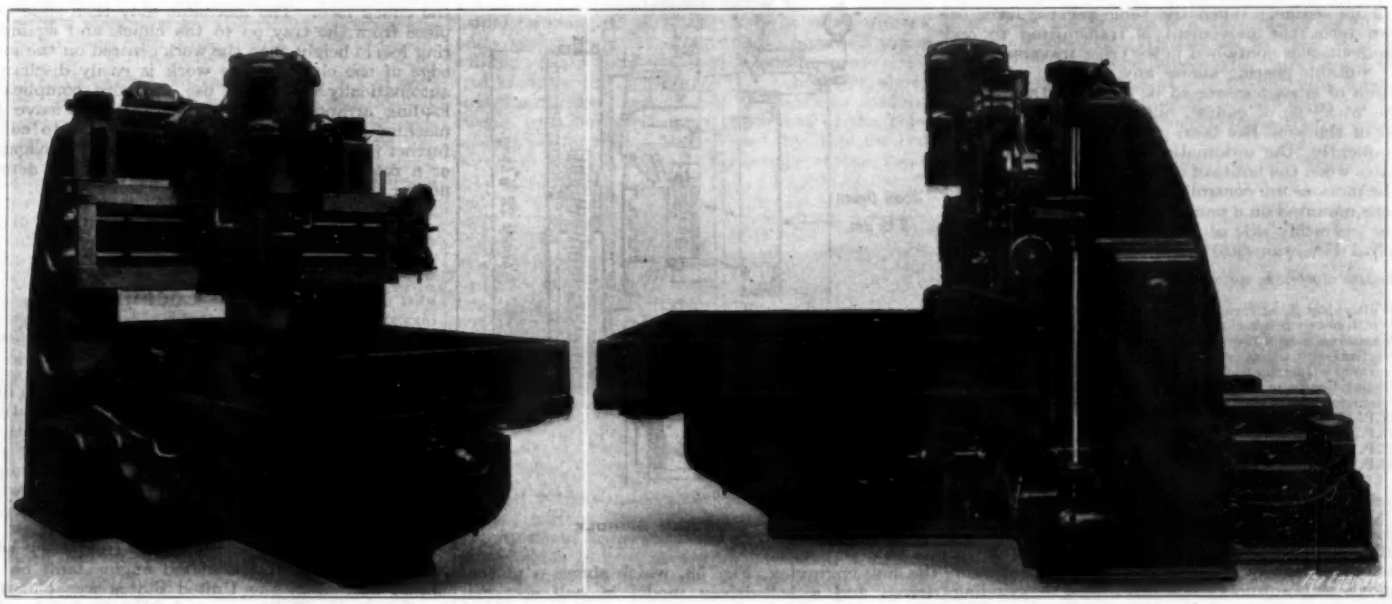


Fig. 54—Blanchard Automatic Surface Grinding Machine



Figs. 55 and 56—Churchill Plano-Type Vertical Spindle Surface Grinding Machine

by the same makers, the saddle is reciprocated by an electric motor driving, through worm reduction gear, a spiral engaging with a straight rack situated beneath the saddle. Reversal of the table motion is operated by adjustable tappets on the saddle. Inching control is provided, so that the table may be slowly moved into position when the wheel is to grind close up to a shoulder or projection. The driving motor is of the ordinary reversing type, and the saddle traverses at a fixed speed of 20ft. per minute. To support the columns two pedestals are cast integral with the bed. They carry a cross rail, upon which is mounted the grinding head, driven from a motor mounted above it through a spline shaft. The feed or vertical range of the wheel is 12in. The wheel spindle is supported by a large-diameter vertical ram, and is of the over-balanced type already described. It runs in roller and ball bearings, and has a flanged end to which is bolted the wheel plate carrying the grinding wheel. By mounting the whole wheel head on four adjustable points it is possible to line it perfectly parallel to the work table; or, if desired, it can be tilted slightly, so that only one edge of the wheel is cutting. When the rotary table is in use the downfeed of the wheel is driven by a separate motor, but when the reciprocating table is in use it must be operated by hand.

A Plano-Type Machine.

The plano-type vertical spindle grinding machine was designed to grind flat surfaces, the width of which was too great to be covered by the diameter of the wheel at one stroke of the reciprocating table. The only limitation upon the width that can be ground in this type is provided by the strength and rigidity of the cross rail that carries the grinding head. The latest production of the Churchill Machine Tool Company, Ltd., of this class of machine is illustrated by the engravings, Figs. 55 and 56. Save only that a grinding wheelhead is mounted on the cross-slide, it is built much like a planing machine. Besides a 4in. adjustment of height by the feed mechanism of the head, the cross rail may be raised or lowered 20in. on the columns, either by power or by hand. The grinding wheel spindle is made of Nitralloy steel, and runs in roller bearings and heavy ball thrust washers take the thrust. It is driven by a vertical spindle motor mounted upon a bracket overhanging the wheelhead carriage, and transmitting the power through a spline shaft and sleeve. On either side of the motor are mounted spring-loaded counterbalance drums for the wheelhead. The reciprocation of the table is operated hydraulically; the cylinder of the mechanism being attached to the bed of the machine, while the table moves with the piston. A motor mounted on the floor near the base of one of the columns drives the oil pump while the reversal of the motion is brought about by adjustable dogs on the table which throw over a lever controlling the reversing valve. The same motor operates the automatic cross traverse through a mechanism that is driven continuously, but is only allowed to transmit its motion to the carriage when the table reaches the end of its stroke. When the table reverse lever is thrown over, the movement is transmitted to an escapement gear contained in the cross traverse gear-box. Suitable gearing allows any of three separate amounts of cross traverse to be chosen. Down-feed of the wheel is, of course, only required when the whole of the area has been ground for one setting. Consequently, the automatic feed mechanism only operates when the limits of cross traverse are reached. All the motions are controlled from a number of push buttons mounted on a panel built against the column on the operating side of the machine. Some of the principal dimensions are given in the following table:

Length of working surface of table	62in., 72in., 96in., or 120in.
Width of working surface of table	36in.
Width between uprights	63in.
Maximum height under new grinding wheel	24in.
Vertical adjustment of grinding wheelhead ..	4in.
Vertical adjustment of cross rail	20in.
Cross adjustment of grinding wheel	38in.
Diameter of segmental grinding wheel	18in.
H.P. of wheelhead motor	20
H.P. of traverse drive motor	5
H.P. of reversing motor for elevating gear ..	3
H.P. of coolant pump motor	1

An Automatic Surface Grinder.

As has already been pointed out, the vertical spindle type of surface grinding machine has a great capacity for high output. By making a number of the movements automatic and performing the grinding operation by one pass below the wheel, the productivity can be greatly increased. The machine illustrated in Fig. 54, made by the Blanchard Machine Company, of Cambridge, Mass, U.S.A., for which Burton, Griffiths, Ltd., are agents in this country, is intended for the rapid finishing of small parts, and is truly automatic, since the operator has only to place the work on the machine. The operations of chucking, grinding, measuring, unloading, de-magnetising—if necessary—and clearing the chuck face in readiness for further work are performed entirely by the machine. A magnetic chuck is employed. It rotates continuously at slow speed conveying the pieces from the loading point, first under the grinding wheel, then beneath a wheel control calliper, which maintains the correct size, and finally to the unloader, at which point the pieces leave the chuck, and are discharged from the machine. The magnetising of the chuck is so arranged that while the work is firmly held beneath the wheel, it is free to move at the unloading point. One pass beneath the wheel finishes one side of the work. If it is necessary to grind both sides, several thousand are passed through and ground on one side to a thickness sufficient to leave an allowance for subsequent grinding of the other side.

The grinding head of the machine is mounted upon a heavy base section column, secured to the base at three points spread far apart. A section through one of these supports is shown in Fig. 57, from which it will be seen to be adjustable. A bush is screwed into the hole in the flange of the column. Above it is a specially shaped washer, having two lugs on its underside, which engage with slots in the top of the bush. The upper part of the washer is hexagonal, and at its

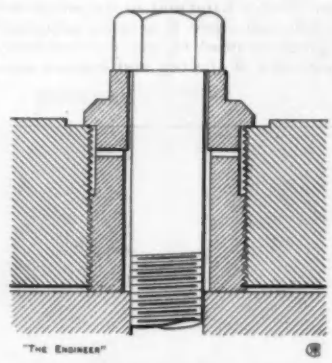


Fig. 57—Adjustable Support

widest it is greater in diameter than the hole. By the use of a spanner, it may be rotated, thus screwing the bush down or up and causing it to project beyond the base of the column by a greater or smaller amount. The column is held firmly down by a bolt passing through clearance holes in the washer and bush, and screwing into the base. By the use of these adjustable supports the spindle may be brought square with the work at any time, while for grinding concave or convex it may be tilted to the required degree.

The grinding wheel is mounted directly on the end of its driving motor spindle, which is a heavy steel forging. The whole spindle with motor windings and fan is carefully balanced. An angular contact ball bearing with its outer race in a sliding sleeve pushed upwards by springs supports the upper end of the spindle, which is carried below in a Timken precision bearing. The arrangement can be seen in

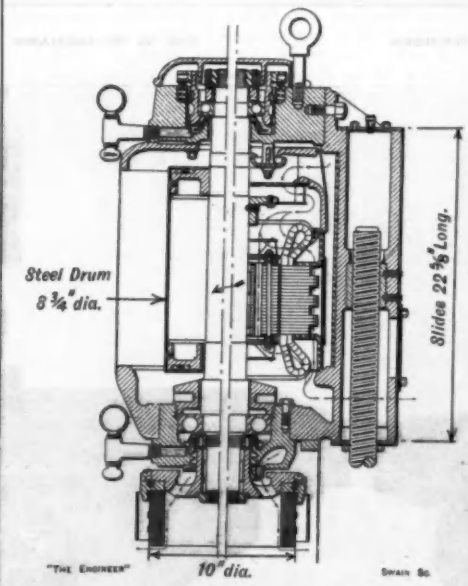


Fig. 58—Grinding Spindle

the line engraving, Fig. 58, which shows a motor-driven and a belt-driven model in half sections. The upward spring force is great enough, not only to support the spindle, but also to create a heavy upward thrust on the lower bearing. It is claimed that the arrangement eliminates all backlash and compensates for variations in temperature. Cooling of the motor is effected by drawing air from above and delivering *vid* the windings to an outlet at the bottom. Either a D.C. or an A.C. motor may be used, the most popular being a 25 H.P., 900 r.p.m., 60-cycle A.C. The arrangement for raising or lowering the wheelhead by means of a screw and nut mechanism can also be seen in the engraving.

Either a ring or a segment wheel can be used. The former is set with sulphur into a cast iron ring, which can be fastened to the face plate by six screws, and remains within the ring until worn out. A segment wheel is more economical and faster cutting than a ring on broad surfaces, such as a piece of steel plate. It has also the advantage that the gaps between the segments allow the water from within the wheel to wash away the chips. Not all kinds of work are suited to segment wheels, however. Pieces that stand high above the chuck and have no great area of contact with it are preferably ground with a ring wheel. Although the relative motions of chuck and wheel tend to keep the face of the latter true, and even if not perfectly true, a plane surface will still be generated, it may be necessary to sharpen the wheel at intervals, and a new wheel may need truing once. For this purpose a wheel dresser is fitted to the machine. It consists of a vertical bronze shaft carried in a heavy bearing attached to the wheelhead. At the lower end of the shaft there is an arm carrying a group of toothed steel cutters. A handle at the top of the shaft allows the cutters to be swung across the wheel face. Micrometer adjustment for height is provided by a hand nut just below the operating handle.

The work table is rotary, and the work is held thereon by a magnetic chuck, which has already been described. On a similar machine, not designed for automatic operation, the table is arranged to slide out from beneath the wheel. After laying and arranging the work upon the magnetic chuck, a switch is closed, bringing the magnetism into play and the table is pushed by hand to the working position beneath the wheel. In this position it is rotated continuously by power, while the wheelhead is fed downwards automatically at the rate of 0·001in. to 0·002in. per revolution of the work until the desired size is reached. The wheelhead is then raised, the chuck rotation stopped, the table withdrawn from beneath the wheel, and the work removed. The sliding motion of the table is only used for bringing the chuck clear of the wheel, never for grinding; but the rotation may be started at any position so that parts with a central projection may be ground by traversing the table no further than is necessary for the wheel just to clear the obstruction. Rotation of the chuck is controlled by a foot pedal, so that the operator's hands are free for loading and unloading the work. Six speeds are available. The feed mechanism is equipped with an automatic sizing stop, and is capable of giving a rate of 0·0002in. per revolution of the work, if so great an accuracy is required. Power can be used for raising or lowering the wheelhead rapidly.

Coolant water is supplied, both outside and within the wheel. Referring again to Fig. 58, it will be seen that water is brought in through an opening in the wheelhead, and passes through holes in the face-plate on which the grinding wheel is mounted. Whirling with the rotation, it is driven out across the face of the wheel, even passing between the wheel and work in the spaces between the grains of abrasive in the wheel face. It is collected in a tank, with a capacity of over 180 gallons, in the base of the machine.

Operation of the automatic machine is facilitated by the use of trays, the floors of which are level with the chuck face. The mechanic may then slide each piece from the tray on to the chuck and against a ring less in height than the work centred on the inner edge of the chuck. The work is easily discharged automatically. By the use of more complicated loading arrangements, the operator can leave the machine for a minute or two in order to collect further pieces, the chuck being fed from a magazine or a rotating table with suitable guides. A demagnetiser may be mounted on the discharge side.

(To be continued.)

Mallet Type Locomotives.

By E. C. POULTNEY.

No. I.

In the present articles the writer proposes to illustrate and offer a few notes on Mallet type locomotives, as used on the railways of the United States, with the idea of grouping together for general reference purposes, the characteristics of certain notable examples of a locomotive type which is largely used and which has been developed for both through-road services as well as pusher assistance on heavy gradients.

The use of the Mallet type dates from 1904, when the first compound articulated engine built on the Mallet system in the United States was placed in service on the Baltimore and Ohio Railroad. This engine weighed without tender 334,500 lb., 149 long tons, and had a tractive effort, working compound, of 71,500 lb. The writer believes that this locomotive was also the first in the United States to be fitted with Walschaerts' motion.

While from the above it will be seen that the Mallet articulated design has been in evidence for a long time, it is nevertheless true that only during more recent years has the type been developed to the proportions shown in the examples selected for treatment in this article.

The continued increase in freight train loading, coupled with the desire for higher speeds, has gradually increased the power required, and large non-articulated engines, having from, say, 70,000 lb. to 90,000 lb. tractive effort, have become common. To

develop the last-named tractive force with only two cylinders, requires pistons of 29in. or 30in. diameter, with working steam pressures around 200 lb. or as high as 250 lb. per square inch. Such dimensions, it goes without saying, cause enormous stresses in the framing, and add to the weight of the connecting and coupling-rods, to the size of the crank pins, and to the proportions of crossheads and slides. Difficulties in counterbalancing arise, owing, in part, to the heavy revolving and reciprocating masses, and, in part, to the small diameter drivers required in the interests of high tractive efforts. Much ingenuity has been shown in the design of motion details to combat the forces they have to transmit, and multiple bearing crosshead slides, articulated connecting and coupling-rods, together with floating bushings, for the main crank pin bearings, have been largely introduced.

Further, the advent of the booster and four-wheeled trailing truck have added to the starting tractive effort, and steaming power of the normal non-articulated locomotive, but, even so, the division of the power over two engines and the development of the required effort by four, in place of two pistons, present possibilities, not only from the point of view of reduced stresses, but as a means of easing the balancing problem.

The use of four cylinders makes compounding possible, and under certain conditions, good economies have been attained, for the reason that, when exerting their normal maximum tractive power, such engines work of necessity with a reasonable degree of expansion.

Road trials carried out on the Pennsylvania with a large compound Mallet belonging to the Norfolk and Western, showed that at 2758 I.H.P. and 12 miles per hour, the steam required per I.H.P. hour was only 17·8 lb. and per D.B.H.P. 24·2 lb., and the mean results from maximum and minimum figures showed steam rates of 16·5 lb. and 19·46 lb. respectively. This locomotive had cylinders—H.P., 24½ by 32, and L.P., 39 by 32, taking superheated steam at 230 lb. pressure, the superheat being about 206 deg. Fah.

The writer has no actual figures for the water rate per cylinder horse-power for simple expansion Mallets, but later data appertaining to the performance of some large simple Mallets on the Chesapeake and Ohio will be given. These trials show an average water consumption of 23·32 lb. per D.B.H.P. hour, at 20·5 miles per hour and 42 per cent. cut-off, the regulator being full open and the steam pressure 204 lb. per square inch. At this speed, corresponding to 120 r.p.m. with 57in. wheels, the mean effective pressure is approximately 50 per cent. of the working pressure.*

The engine has four cylinders 23 by 32 and 57in. drivers, so that the indicated tractive effort would be

$$\frac{23^2 \times 32 \times 204 \times 0{\cdot}50}{57} \times 2 = 60{,}200 \text{ lb.}$$

From which the cylinder horse-power at 20·5 miles per hour becomes

$$\frac{60{,}200 \times 20{\cdot}5}{375} = 3310 \text{ I.H.P.}$$

The mean power at the drawbar was 2632 H.P., and the water per D.B.H.P. hour 23·32, so that based on these figures, we have for the water per I.H.P.

$$\frac{2632 \times 23{\cdot}32}{3310} = 18{\cdot}5 \text{ lb.}$$

As will be later mentioned, one of the chief difficulties met within compound engines is the great width required to accommodate sufficiently large L.P. cylinders. This has been the leading factor in the introduction of the four-cylinder simple-expansion Mallet, but some attempt has been made to reduce steam consumptions at full power by restricting the point of cut-off in full gear, and examples are to be found in which the maximum rate of admission is 65 or 70 per cent. in place of the 85 or 90 per cent. customary in American practice. These shorter cut-offs materially reduce the water rate in full gear, which at about 90 per cent. approximates 32 lb. per I.H.P. hour, comparing with about 25 lb. and 23 lb. for 70 and 65 per cent. cut-offs respectively.†

These water consumptions are those expected at low speeds (r.p.m.), and are naturally reduced at increasing speeds. The earlier cut-offs in full gear also improve the valve events somewhat by the better port openings obtained when the gear is linked up.

Other factors in the economical production of power are the almost universal use of feed-water heaters, large superheaters, and high working pressures. The principal dimensions of the various engines described are given in tabular form, along with the proportions of the related dimensions, but a note concerning the boiler ratios shown may be of interest.

The Mallet system of articulation naturally demands a type of boiler having a relatively long barrel section, especially when eight or ten coupled power units are required. For this reason rather long tubes are found, and the heating surfaces, it might be thought, would be made up of relatively large tube surfaces, and, further, that the evaporations required would call for a heavy blast with high back pressures.

A study of the boiler proportions, however, shows that the ratios of fire-box and tube surfaces conform closely with normal practice, and that of the total heating surface that contributed by the fire-box portions, forms a normal percentage of the total. Further, while considerable variation is shown, the heating surface furnished for each square foot of grate is about an average amount; in other words, it is possible to provide a grate of sufficient size to obtain reasonably high rates of evaporation per unit of heating surface.

In the matter of the draught required to move the air through the fuel bed and overcome the resistance of the tubes, this appears not to be excessive, for, referring to the results given of tests with the C. and O. Mallet, having 2¼in. tubes, 24ft. long, the mean back pressure recorded is shown to be only 8·2 lb. per square inch for an hourly evaporation of 62,000 lb., corresponding to about 9·6 lb. per square foot of evaporative heating surface, and a firing rate of 81·3 lb. of coal per square foot of grate per hour.

It would appear, therefore, that while the boilers are of necessity rather long, the mean evaporative power of the heating surfaces is normal, and that the power developed per square foot of heating surface is about equal to that obtained with average non-articulated locomotives.

It should also be remarked that the liberal running dimensions admitted in the United States allow the fire-box portion of the boiler to be carried over the coupled wheels. This, together with the use of a combustion chamber extending forward into the barrel, reduces the length of the tubes, and the general construction naturally permits of adequate fire-box heating surfaces and furnace volume, and also a large grate area. In this connection attention is drawn to the light weight of these large engines relatively to the heating surfaces. The dimensions of the U.S.R.A. standard design are given in the table, in order to establish some means for comparing the relative sizes and proportions of the other locomotives with what may be termed an average design, thus bringing the others into proper perspective.

Dimensions and Proportions of Mallet Type Articulated Locomotives.

Railway	U.S.R.A.¶	Virginian	C. and O.	G.N.	N.P.	W.P.	B. and O.
Builders	Standard design	Am. Loco. Co.	Am. and Bald.	Baldwin	Am. and Bald.	Baldwin	Baldwin
Wheel arrangement	2-8-8-2	2-10-10-2	2-8-8-2	2-8-8-2	2-8-8-4	2-8-8-2	2-6-6-2
Tractive effort—							
Simple, lb.	121,000	176,600	103,500	127,500	140,000	137,000	90,000
Compound, lb.	101,300	147,200	—	—	—	—	—
Engine weight, lb.	531,000	684,000	569,830	594,940	715,000	665,100	465,000
Weight on drivers, lb.	478,000	617,000	491,840	532,800	553,000	552,700	372,000
Tender weight, lb.	262,100	214,300	299,070	321,560	401,000	408,250	273,000
Wheel base, engine, ft. in.		64–3	58–1	58–2	66–8	61–5	56–0
Wheel base, engine and tender, ft. in.		97–0	104–8½	96–3½	111–11	108–0	104–4½
Cylinders, H.P., diameter and stroke, in.	25×32	30×32	23×32	28×32	26×32	26×32	23×30
Cylinders, L.P., diameter and stroke, in.	39×32	48×32	—	—	—	—	—
Driving wheels, diameter, in.	57	56	57	63	63	63	70
Steam pressure, lb.	240	215	205	210	250	235	250
Heating surfaces—							
Fire-box total, sq. ft.	435	516	473	432	872	639	866
Tubes and flues, sq. ft.	5,685	8,090	5,955	6,710	6,801	6,141	5,677
Evaporation, total, sq. ft.	6,120	8,606	6,428	7,142	7,673	6,880	6,543
Superheater, sq. ft.	1,475	2,120	1,885	1,896	3,219	2,152	1,666
Combined, sq. ft.	7,585	10,726	8,213	9,038	10,892	9,032	8,209
Grate area, sq. ft.	90	108·7	113	108	182	145	92
PROPORTIONS AND RATIOS.							
Weight on drivers ÷ weight of engine, per cent.	90·0	90·2	86·3	89·5	77·4	83·2	80
Weight on drivers ÷ tractive effort†	4·7	4·19	4·75	4·18	3·95	4·02	4·13
Weight of engine ÷ combined heating surface	70·1	63·7	68·6	65·8	65·8	73·7	56·7
Fire-box surface, per cent.*—							
Combined heating surface	5·74	4·81	5·76	4·78	4·78	7·08	10·52
Fire-box surface ÷ grate area*	4·53	4·75	4·19	4·0	4·79	4·41	9·4
Superheater surface, per cent., combined heating surface	19·4	19·76	22·68	20·96	29·57	23·8	20·2
Combined heating surface ÷ grate area	79	98·6	73·7	83·7	59·6	62·1	88·9
Tractive force × diameter drivers ÷ combined heating surface†	715	705	710	888	810	957	768
Type of superheater	A	A	A	A	E	A	A

* Fire-box heating surface includes arch tubes and syphons when applied. † For compound engine tractive effort is as for compound gear.
B. and O. engine fitted with Emerson water-tube fire-box.

COMPOUND MALLET ENGINES.

The largest compound Mallets ever built were those introduced on the Virginian Railway in 1918, a photograph of which is reproduced in Fig. 1. These engines, of impressive proportions, have boilers having no less than 10,726 square feet of heating surface, including 2120 square feet provided by the superheater, which, at that time, was said to be the largest ever fitted to a locomotive. The locomotives were built to meet exceptionally difficult operating conditions, occurring over a particular section of the line, over which there is a very heavy traffic, consisting of coal trains made up to 5850 tons gross weight, or 5220 long tons. The trains have to be worked over 14 miles of a 2·07 per cent. gradient, requiring a tractive effort at, say, 10 miles per hours of about 146,250 lb., without allowance for resistance, due to curvatures.

The cylinders are arranged in the manner usual with Mallet compounds—that is, the H.P. cylinders are mounted on the rear, or fixed framing, and the L.P. forward on the articulated section. Piston valves are used for the H.P., and flat valves for the L.P. cylinders, and the respective dimensions are H.P. 30 by 32 and L.P. 48 by 32, which, with 56in. drivers and 215 lb. steam pressure, give estimated tractive efforts of 176,600 lb. and 147,200 lb. in simple and compound gear respectively.

In order to provide for sufficiently large main and side rod pins, and proper spacing for the frame fits, the cylinders are spaced at 90in. centres, giving a total of 143½in. as the maximum width, over the L.P. cylinders. This distance over the cylinders limits the use of the engines to certain sections of the road, and provides the chief reason why recent Mallet designs are of the simple expansion type, as clearances do not in general permit of a greater overall dimension of more than 129in., which was the width allowed in the case of the U.S.R.A. heavy Mallets, having 39in. L.P. cylinders. This is, however, a maximum figure, and the standard overall dimension

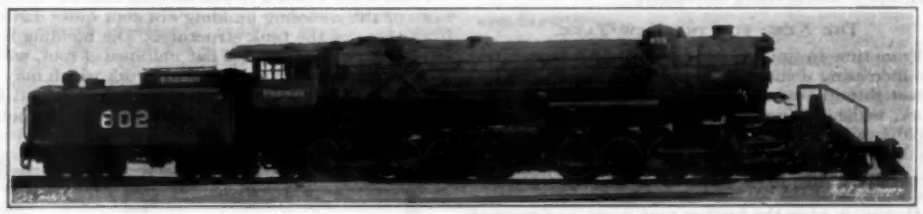


FIG. 1—VIRGINIAN RAILWAY—COMPOUND MALLET LOCOMOTIVE

* "Locomotive Resistance and Tractive Force," Kiichi Asakura, *Railway Mechanical Engineer*, September, 1924.

† "Fifty per Cent. Cut-off Locomotives," W. F. Kiesel, Jr., New York Railroad Club, November 10th, 1923.

laid down when the U.S.R.A. standard designs were evolved was less by 5in., being 124in. (10ft. 4in.).

Returning now to the Virginian locomotives; the boilers have a greatest diameter outside the plating of 9ft. 4⅞in., and are fitted with 381 2¼in. tubes, and 70 5½ flues, the length over the tube sheets being 25ft.

The fire-box has a combustion chamber and a Gaines wall, and has a grate surface of 108·75 square feet. Firing is done by a standard Duplex stoker, and the arch is carried by five arch tubes. Walschaerts' motion, controlled by a power reverse, imparts a 6½in. travel to the inside admission 16in. piston valves for the H.P. cylinders, and a 6in. travel to the flat valves for the L.P. cylinders. The main throttle valve is of the Chambers type, fitted in the steam dome on the rear barrel course, and is outside connected to the driver's control in the cab. The main journals are 12in. diameter by 15in. long and the others 11in. by 13in.

Both the front and leading trucks have 30in. wheels, and journals 6½in. by 13in. Tenders of considerable size are provided; they have space for 13,000 U.S. gallons of water, and 12 tons (2000 lb.) of coal. The total engine weight in working order is 304·7 tons, and with the tender 401 tons (2240 lb.). These engines were built at Schenectady by the American Locomotive Company.

(To be continued.)

The New Tank at Teddington.

No. I.

At three o'clock this afternoon, Friday, November 18th, the Lord President of the Council, Mr. Stanley Baldwin, F.R.S., will formally open the new tank at the William Froude Laboratory of the National Physical Laboratory at Teddington. In what follows we give a general description of the tank, and in our next issue we shall refer to the events connected with the actual opening ceremony.

The Need for the New Tank.

From time to time we have recorded in our columns the increasing demand for commercial test work and investigations connected with experimental tank work, which during the last ten years has grown so rapidly as seriously to impede more general and fundamental research at the Alfred Yarrow Tank and has often caused such delay in completing tests that the work has been withdrawn.

Having in view the further continuation of research work, upon which the maintenance of the pre-eminent position held by the British shipbuilding and shipping industries so closely depends, and the provision of increased facilities for commercial work, representations were made to the Government in 1929 by the Chamber of Shipping of the United Kingdom, the Liverpool Steamship Owners' Association, and the Department of Scientific and Industrial Research, and on February 20th, 1930, when speaking at the annual dinner of the Chamber of Shipping, Mr. J. H. Thomas, then Lord Privy Seal, announced, it may be recalled, the Government's decision to build a new tank at Teddington at an estimated cost of £45,000. Work was started in the autumn of 1930 and completed a few weeks ago. This tank, while having sufficiently large dimensions for ordinary ship testing work, is longer than the Alfred Yarrow Tank and will therefore be able to undertake testing and research work connected with high-speed motor and flying boats.

Since the building of the new tank was started a gift of £5000 has been made to the William Froude Laboratory by Sir James Lithgow, which has enabled a propeller tunnel to be provided for the study of propeller action under varying pressures, thereby filling the last gap in the testing equipment of the Laboratory.

Before passing to the technical features of the new tank it may be recalled that in 1914 there was only one comparatively small tank on the Continent devoted entirely to mercantile work. There are now no less than five, two at Hamburg and one each at Vienna, Amsterdam, and Rome, all of which are as large or even larger than the Alfred Yarrow Tank at Teddington. There are thus, it may be pointed out, four large tanks serving the needs of the mercantile marine of Germany, Holland, and Italy, the total tonnage of which, according to Lloyd's Register, is only about one-half that of Great Britain and Ireland.

The Tank Equipment.

As the accompanying drawings and engravings show, the new tank, situated next to the Alfred Yarrow Tank, is a monolithic ferro-concrete water basin. It has an overall length of 680ft. and a clear width of 20ft. at the surface of the water, except at the eastern end, at which a small dock for the models, 19ft. in length and 3ft. wide, is provided. As Fig. 2 shows, the depth of water at the eastern end is 9ft., and this depth extends for a distance of 464ft., over which the cross section is almost rectangular. Fig. 2 is a typical cross section of the tank in this part. From the deep eastern end the bottom rises at a uniform gradient for a distance of 36ft. to the shallow western end, which has a depth of 2ft. for the remaining length of 180ft.

In constructing the basin special precautions were taken to avoid undue stresses and prevent cracks developing in the concrete owing to shrinkage during the periods of setting and hardening. The bottom and the walls were built in sectional lengths of 20ft., separated by 3ft. wide gaps, which were built in after the adjacent parts had set and hardened. The interior surface of the tank was finally rendered with cement as a continuous coat, which was well conditioned by keeping it wet for some time so that hardening only took place at a comparatively slow rate.

From Figs. 1 and 2 it will be seen that the foundations of the enclosing building are kept quite distinct from those of the tank structure. The building is of steel and concrete, with a flat unimpeded roof, which will be available for any open-air work which may be required. The gangways between the tank and the building have a width of 2ft. 6in. and run the entire length of the building at each side. Provision has been made for a possible future extension to the tank at its eastern end.

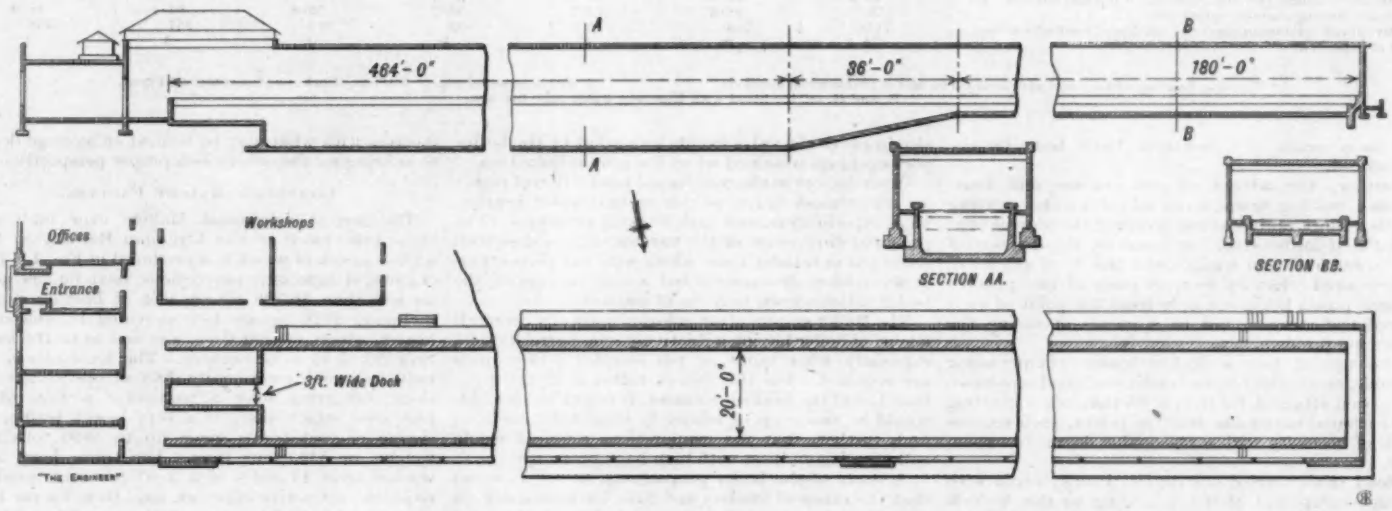


FIG. 1—PLAN AND ELEVATION VIEWS OF NEW TANK AND ENCLOSING BUILDING

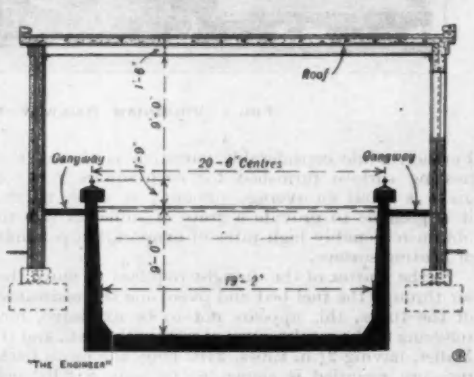


FIG. 2—A TYPICAL SECTION

Fig. 2 shows the rails for the travelling carriage, which are laid upon the longitudinal walls at a height of 1ft. 9in. from the normal water level to the rail tops. The level of water can be adjusted by a sluice valve at the western end of the tank, which allows the depth over the shallow part to be varied. The standard 2in. face rails are machined both top and bottom and the faces finished by grinding to an accuracy of five-thousandths of an inch. They are cleated to cast iron sleepers and are so fixed that a deviation of no more than eleven-thousandths of an inch in level has occurred over a length of 400ft. in the centre during a long period, thereby giving some evidence of the probability of its permanency. The sleepers are laid longitudinally and are of special section, embodying a planed brake rail on which two pneumatically-operated slipper brakes operate. The main braking gear is of the standard Westinghouse railway pattern, working with compressed air, and was supplied by the Westinghouse Brake and Saxby Signal Company, Ltd., of London. The brake slippers are so dimensioned that the applied load can be increased up to 80 per cent. of that on the rear girder. In addition to the main braking gear on the rear girder there is a light electric brake on the forward girder, which is mainly employed for slow-speed work. The main brakes are also interlocked with the electric controls for the travelling carriage, so that in the event of a failure of current they are immediately brought into operation. At certain prearranged positions there are trip stops on the sleepers, which can be set to put on the brakes at any point particularly desired.

The Travelling Carriage.

In Fig. 3 we reproduce a plan and two elevation drawings of the travelling carriage. It is a light mild steel-framed structure rectangular in shape, and by employing tubular steel bracing the remarkably light weight of only 10,000 lb., including both mechanical and electrical equipment, has been obtained. The main dimensions are as follows:—Wheel base, 15ft. 5½in.; length over main frames, 19ft. 11½in.; length over projecting platforms, 24ft. 5½in.; clearance above water level, 1ft. 6in.; height from rail level to top of frame, 2ft.

As shown by our drawing, it consists essentially of two transverse framed and braced portions, each 4ft. 9in. wide, supported on the running wheels, these two main structural frames being connected by six longitudinal girders, of which one is over each rail whilst the remaining four carry the working platforms and instrument supports.

In the central portion of the carriage there is an open well, 10ft. 5¼in. long by 3ft. 8in. wide, within which the model testing apparatus is erected. The running wheels, of 18in. diameter, are turned and ground true on their shaft and are flat on the 2¼in. tread. True fore-and-aft running is maintained by adjustable guide rollers with a ⅝in. face arranged fore and aft on the north side of the carriage, which engage on the machined sides of the rail head on the north wall of the tank, the rail head being machined all over for this purpose and laid to the true line previously referred to.

The main contractors for the travelling carriage, the track, and the electrical and mechanical equipment were Markham and Co., Ltd., of Chesterfield; and the General Electric Company was responsible as sub-contractor for the electrical part of the contract, the overhead lines and the current-collecting gear being supplied by Brecknell Willis and Co., Ltd., of Bristol. As will be seen from our illustrations, there are two electric motors mounted in the middle line of the main transverse frames of the travelling carriage. Each of them has a designed output of 56 B.H.P. They drive the carriage through pinions and spur wheels with a 4 to 1 reduction. The motors and the other electrical equipment receive current from seven overhead lines supported on the roof of the building, the collecting gear being carried on a light steel tower mounted on the forward end of the carriage, as shown in Fig. 7, page 512.

The main electrical equipment for the new tank

consists of a 480-volt main battery and a 110-volt exciter battery, which supply current to a Ward-Leonard motor generator set of 105 B.H.P., which serves the two carriage motors. The control gear for the carriage is mounted on a desk at the side of the tank, thereby relieving the carriage of considerable weight. It is designed for hand operation and for steady speeds from 2ft. to 30ft. per second in one continuous range. Tests have shown a speed of 32·5ft. per second with a still further possible increase in speed.

All the measuring apparatus has been designed and built in the tank workshops. The carriage has been designed so that as far as possible the same testing apparatus can be used in either tank, and runways, indicated in Figs. 4 and 8, are provided for the transportation of models from one basin to the other. The new tank is being equipped with special apparatus for testing model screws in open water, a small motor generator set with controls being fitted on the travelling carriage for this purpose. It is proposed to carry out all propeller tests on model hulls with internal propulsion, as in the ship, recording gear being carried in the model. These tests are to be demonstrated at the official opening.

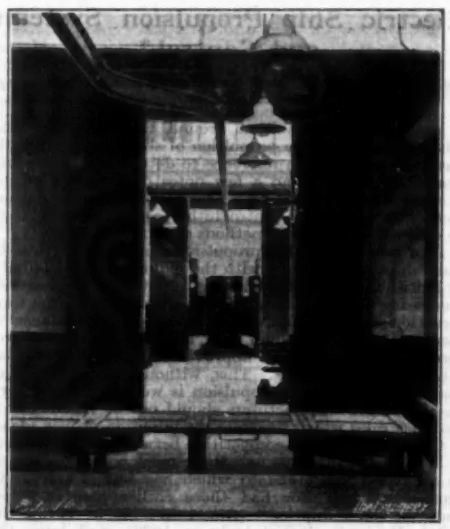


FIG. 4—WORKSHOP AND ELECTRIC CONTROL ROOM

Among the equipment for the new tank model workshop we noted a four-vat wax melting tank, electrically heated, which will deal with 2000 lb. of wax at a casting temperature of about 145 deg. Fah. By a suitable arrangement of the heating elements a very even temperature has been obtained throughout the wax bath, greatly facilitating quick casting operations. In order to supply compressed air for the carriage braking gear there is a small electrically-driven air compressor, delivering air at 90 lb. per square inch to the storage tank, from which tappings are run to various points along the length of the tank. There is a small air storage cylinder on the tank carriage, which is filled from the air pipes and which suffices for several hours' braking service.

The architect for the new tank building was Mr. J. Bradley, and the design and equipment were supervised by Mr. A. G. Ramsay, both of H.M. Office of Works. The tank and its containing building were constructed by Wilson, Lovatt and Sons, Ltd., of Wolverhampton; while H. H. and F. Roll, Ltd., of Epsom, built the new office accommodation.

(To be continued.)

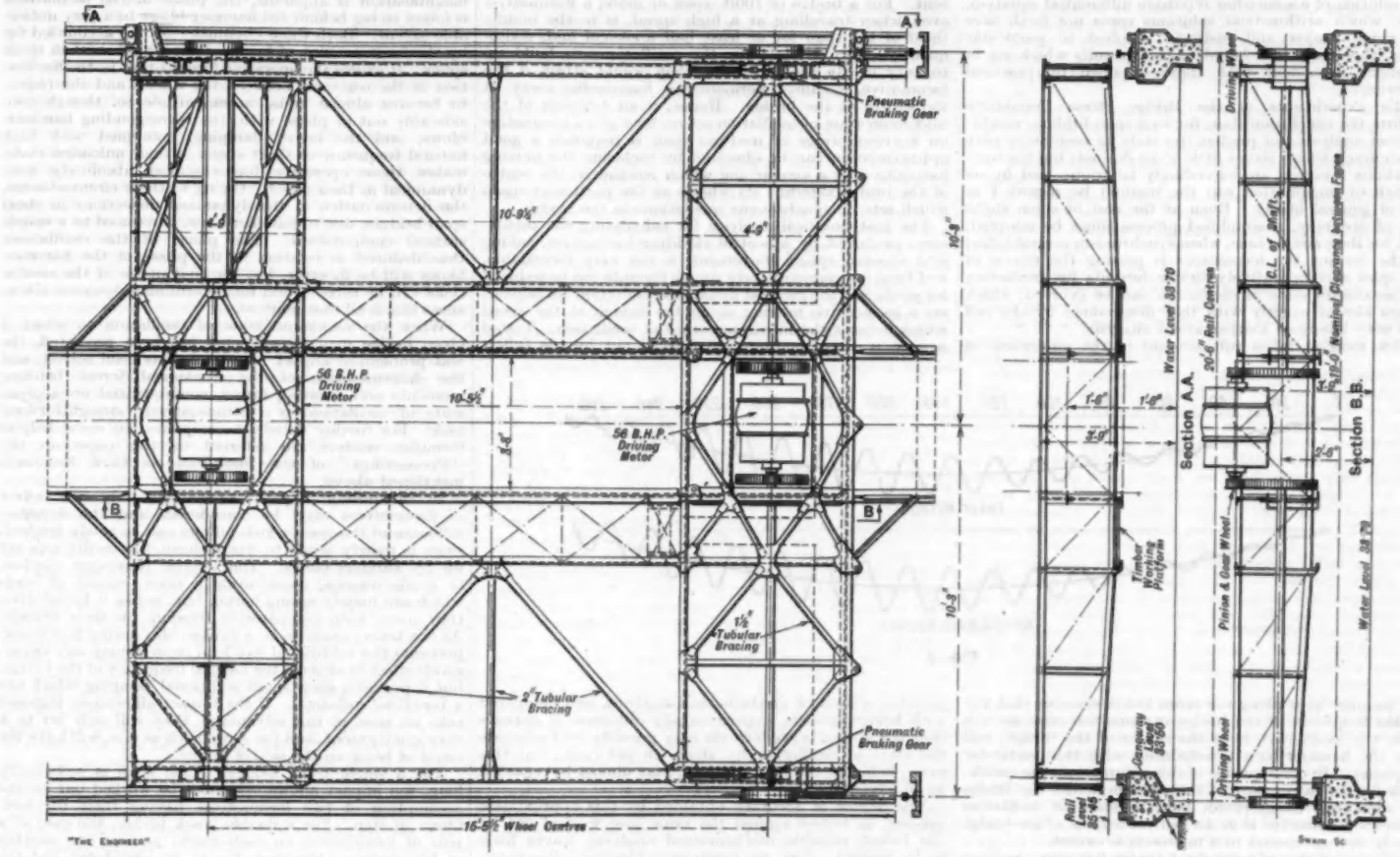


FIG. 3—THE TRAVELLING CARRIAGE

American Engineering News.

Air-Rights Buildings.

As railway terminals in large cities occupy land of high value, many railways in America are developing this property by erecting buildings over it, or leasing the "air rights" from a level about 25ft. above the ground. In Chicago, the Merchandise Mart—said to be the largest commercial building in the world—stands over the two-storey goods station of the Chicago and North-Western Railway; the 23-storey *Daily News* Building stands partly over the north approach to the Union Passenger Station; and the new post-office and railway mail terminal is built entirely over the south approach. At New York, several tall hotels, offices, and apartment buildings bestride the approach to the Grand Central Station. This development of property values is especially practicable where the railway is operated by electric traction, while for steam traction—as at Chicago—ventilating shafts and fans provide for removal of smoke and gases. One of the latest of these air-rights buildings is a warehouse and factory structure covering the site of the goods terminal of the Lehigh Valley Railroad at New York. It is 200ft. by 600ft. in plan, and from nine to nineteen storeys in height, of steel frame construction for the first three storeys, and then of reinforced concrete. Steel framing is required in the lower portion, where the lay-out of the railway tracks necessitates an unsymmetrical arrangement of columns, and long open spaces spanned by trusses. Many small and moderate manufacturing concerns can be accommodated, as large elevators or lifts provide for carrying wagons and motor trucks to every floor, so that materials and goods can be delivered and shipped direct. Other elevators provide direct connection with the platforms of the goods station, for the receipt or shipment of goods by rail. The floors are designed for live loads of 200 lb. and 250 lb. per square foot.

Locomotive Developments.

At the annual meeting of the mechanical division of the American Railway Association a report was made on a cut-off control device, which is automatically operated by the back pressure. This device, in use on several railways, is considered to be designed on correct principles, and to be not unduly complicated. In another device, which is still more largely used, the proper cut-off is not made automatically, but indicates in the cab, leaving the engineman to make the necessary adjustment to obtain the maximum power available for a given speed. Its records show which men need further instruction in operating methods, but in general it results in a substantial saving in fuel as well as an increase in tonnage rating. A report on high boiler pressures included ninety with 325 lb., and about 2100 carrying 250 lb. and 225 lb. pressure. Advantages of high pressure and temperature include less water for a given amount of power, with greater capacity for engines of the same weight, with smaller cylinders, valve chests, and steam pipes, and consequently less heat loss by radiation. Disadvantages lie in difficulties of cylinder and valve lubrication, causing increased maintenance and necessitating stronger piping and cab fittings. These conditions may make it necessary to displace the piston type of valve with poppet valves, which do not require lubrication. It was considered doubtful whether special types of boilers are necessary for high pressures, while the simplest way of reducing boiler maintenance troubles was said to be the softening or other appropriate treatment of the water. Tests are being made of a number of automatic couplings or connectors for the brake pipes, but tests of combined car couplings and pipe connectors are not considered desirable at this time. Other reports showed that about 770 motor rail cars and 100 petrol-electric locomotives were in service.

American Sewage Treatment Processes.

After an extended visit to American sewage works, a statement of his views has been given by Mr. John D. Watson, consulting engineer, of London, England. In particular, he noted the enormous quantities of sewage that have to be provided for. The activated sludge, or bio-aeration, process is favoured in both countries, as are trickling filters, while contact beds are now rarely built. At Baltimore there is separate sludge digestion, with trickling filters for secondary treatment, while experiments with mechanical dewatering of sludge are in progress. Spiral-flow aeration tanks are widely used. In 1914, when Mr. Watson reported on the sewage disposal system of Chicago, the sewage from a population of about 3,000,000 in the city and vicinity was delivered to the drainage canal without treatment, and pollution extended far down the Illinois River. At present the sewage from about 2,000,000 is being treated to such a condition that the effluent is stable and the sludge is inert. For this work there have been built sewage works of great size. From one of these works, in a suburban district, the sludge will be pumped several miles to a disposal plant remote from residential districts. With the development of the activated sludge process sewage nuisance has been overcome, so that large sewage works are now built close to centres of population. The utilisation of sewage sludge as a fertiliser, which is being developed in certain cases, as at Milwaukee, does not promise a general solution of the sludge disposal problem, in Mr. Watson's opinion, since its cost and transportation must be low, and it can be applied only on soil of certain characteristics. But the dewatering and incineration of sludge he considered of greater promise, especially where large quantities have to be handled, as at Chicago, with 600 tons of solids daily. The cost is the critical feature, and this can be determined at the new West Works, at Chicago, where a plant for dealing with 20 tons daily has been built.

Dynamic Effects in Railway Bridges.*

By Professor C. E. INGLIS, F.R.S., M.A., LL.D.

(*Concluded from page* 493.)

The complete analysis for the case of a long span bridge, in which the oscillations are not sufficiently active to stimulate locomotive spring movement, involves the solution of a somewhat repulsive differential equation, from which arithmetical solutions come not forth save by much prayer and fasting. Applied to particular cases, this analysis is found to yield results which are in excellent agreement with those obtained by practical experiment.

The experiments of the Bridge Stress Committee confirm the conclusion that, for long span bridges, mathematical analysis can predict the state of oscillation with an accuracy which leaves little to be desired; but the computations involved are exceedingly laborious, and by no stretch of imagination can the method be regarded as one of general utility. Even at the cost of some slight loss of accuracy, a simplified process must be adopted, and, for the extreme case, when synchronism is established at the instant the locomotive is passing the centre of the span a comparatively simple formula for predicting the maximum state of oscillation can be evolved, which agrees almost exactly with that determined by the full and very laborious mathematical analysis.

This method takes full account of the movement of the hammer-blow along the span, but it assumes that the loaded frequency of the bridge remains the same as it is when the locomotive is at the centre of the birdge, and that the hammer-blow synchronises with this particular frequency. In consequence of this assumption, the oscillations for the latter part of the passage across the bridge are somewhat exaggerated, but the state of oscillation when the locomotive is in the central regions of the bridge is only over-estimated to a microscopic extent.

The assumption of a constant bridge frequency reduces the mathematical analysis to the solution of a differential equation of a simple well-known type, and the degree of accuracy obtained is indicated by the two deflection diagrams which appear in Fig. 2. It will be seen that the agreement is remarkably good, and the over-statement of the maximum increase of the central deflection, as given by the approximate method, is less than 2 per cent.

The formula referred to above for determining the maximum state of oscillation is only applicable to long span bridges—that is, broadly speaking, bridges of not less than 200ft. span—in which the oscillations induced are not sufficiently active to stimulate movement in the locomotive springs. For shorter span bridges, the higher frequency at which large oscillations are developed will increase vertical accelerations to such an extent, that the friction in the spring-movement is incapable of giving the spring-borne mass of the locomotive the same up and down motion as the bridge. Spring movement is induced, and this has a profound effect, both on the magnitude of the oscillations, and also on the frequency at which the maximum state of oscillation is developed.

The natural frequency of a locomotive on its springs is usually of the order of 3 periods per second, and, if the bridge is oscillating with a frequency appreciably higher than this, the vertical movements of the spring-borne load and those of the bridge tend to become opposed in direction. Under these circumstances, the inertia effect of the spring-borne mass is in a sense negative in character, and, as a consequence, the mass of the locomotive, instead of lowering the natural frequency of the bridge, may actually raise it above the unloaded frequency. Owing to this, synchronous oscillations in medium span bridges tend to occur at high engine speeds, and since at high engine speeds hammer-blows are large, the dynamic effects in bridges of this class, say, from 100ft. to 150ft. in span, are particularly pronounced. Fortunately, however, spring movement also introduces a beneficial influence which partially counteracts dynamic excesses in bridges of medium span. As soon as spring movement occurs, a reservoir is opened capable of absorbing abundance of energy, and the friction between the leaves of the laminated springs, and more particularly the friction between the axle-boxes and their guides, provides a damping influence far more potent than any damping in the bridge itself.

Predicting the oscillations in a bridge, due to the passage of an unsprung locomotive, by the full mathematical analysis, is not a task to be undertaken in a casual frame of mind, but it is child's play in comparison with the corresponding computations when locomotive spring movement has to be taken into account. It can be done, but, for the complete analysis of a single case, one must be prepared, even with the assistance of a calculating machine, to face a month's work of concentrated effort. Formidable though it may be, this task must occasionally be undertaken, since by this means standards can be set up for checking the accuracy of simplified processes, and particularly an approximate method of calculating the oscillations in the extreme case, when synchronism is established at the instant the locomotive is passing the centre of the span. This approximation is based on the fact that, owing to the very heavy extra damping induced by spring movement, the bridge oscillations mount up approximately to their maximum in a very short space of time. Analysis applied to a typical medium span bridge shows that if a locomotive, standing at the centre of the span, starts to skid its wheels at a speed which sets up synchronous oscillations, then in one second the oscillations will mount up to 99 per cent. of their full value, and at the end of the first half second they will only fall short of this limit by about 10 per cent. For a bridge of 100ft. span or more, a locomotive, even when travelling at a high speed, is in the middle third of the span for at least half a second and, consequently, there is time for the oscillations to build up to very nearly the full value they would attain if the locomotive remained permanently hammering away at the centre of the bridge. Hence, if an estimate of the maximum state of oscillation set up by a given locomotive on a given bridge of medium span is required, a good approximation can be obtained by replacing the moving locomotive by a similar one which remains at the centre of the bridge skidding its wheels at the particular speed which sets up synchronous oscillations in the bridge.

The mathematical analysis for calculating the oscillations produced by a central skidding locomotive, taking into account spring movement, is not very formidable, and from it a comparatively simple formula can be deduced for predicting the greatest dynamical deflection consequent on a locomotive moving along the bridge at the speed which induces the maximum state of oscillation. Tested against a corresponding case worked out by the fullest possible system of mathematical analysis, and compared with bridge records, experimentally obtained, it appears that the approximate formula may possibly over-estimate the state of oscillation by about 10 per cent., but this error, being on the side of safety, may almost be regarded as an advantage.

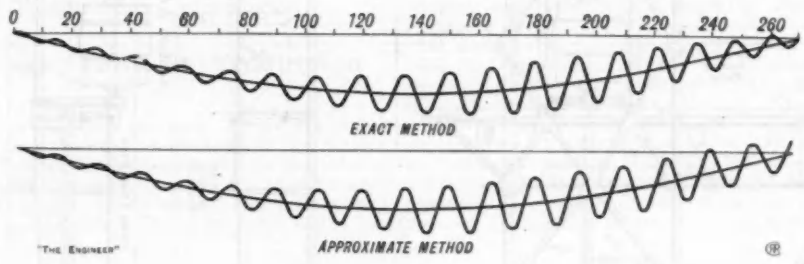


Fig. 2

The degree of accuracy obtained by this approximate process, as tested against the same case worked out by the fullest possible mathematical analysis, leaves little to be desired. But, for computing dynamic allowances, the variation of the state of oscillation is of little interest; in general, it is only the maximum state of oscillation that is required, and, for this purpose, the comparatively simple formula which neglects the motion of translation of the locomotive gives a sufficiently accurate prediction. This formula requires the same bridge data as in the case of long span bridges, but the locomotive characteristics must be given in greater detail.

Thus—excluding the tender—the spring-borne mass, and the unsprung mass of the locomotive, must be known separately, also the frequency of the locomotive on its springs, and the value of the total frictional force resisting its spring movement. The evolution of this formula for determining the maximum dynamical deflection which can be produced by a given locomotive on a given bridge of medium span, is to be found in a paper communicated to the Institution of Civil Engineers in April, 1932.

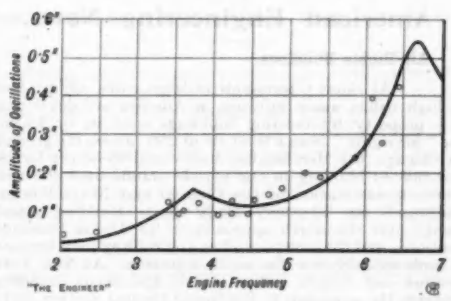


Fig. 3

The principle of replacing a moving locomotive by one skidding its wheels at the centre of the span affords an easy and sufficiently accurate method of predicting oscillations, even in cases where synchronous speeds may not be attainable. The application of this principle is illustrated by Fig. 3, which shows a series of amplitude—frequency—observations obtained by the Bridge Stress Committee, in connection with a medium length bridge of 112ft. span. The observations, though somewhat erratic, can be seen to range themselves along the amplitude-frequency curve deduced by the skidding-locomotive method of analysis.

The amplitude first of all increases with the frequency until it reaches a value of about 3·5. Spring friction then breaks down, and after a slight dip in the curve, the amplitude mounts up again to a maximum when the frequency is a little under 7, though, owing to practical limitations of speed, this high frequency condition of resonance could not be experimentally attained.

The outstanding characteristic of short span bridges is the heavy damping their oscillations display. The damping resistances in a bridge are mainly due to lack of elasticity in the track, and to the fact that the track, being continuous, opposes changes of slope at the ends of the bridge. The terminal damping couples, thus induced, are independent of the length of the bridge, and, while their effect on long span bridges will be slight, their influence on comparatively light short spans is so pronounced, that free oscillations are damped out with almost instantaneous rapidity.

For short spans of 50ft. or less, the analysis of actual bridge deflection records shows that the magnitude of the dynamical deflections can be predicted with great accuracy, by treating the hammer-blows as though they were purely statical in their effect; but, although no dynamical magnification is apparent, the phase of the oscillations is found to lag behind the hammer-blows to a very noticeable extent. Both these circumstances are accounted for by the large amount of bridge damping inherent in short spans. It causes the operative forces—that is, the fluctuation in the reactions between the wheels and the rails—to become almost equal in magnitude to, though considerably out of phase with, the corresponding hammer-blows, and the heavy damping, combined with high natural frequency of short spans in their unloaded state, makes these operative forces almost absolutely non-dynamical in their effect. Owing to these circumstances, the determination of the dynamical deflections in short span bridges, due to hammer-blow, is reduced to a simple statical computation. The phase of the oscillations thus deduced in relation to the phase of the hammer-blows will be in error, but the magnitude of the oscillations will be correct, and for determining dynamic allowances this is all that matters.

When the maximum state of oscillation to which a given bridge may be subjected has been predicted, the real problem of impact allowances has been solved, and the determination of the dynamical forces bending moments and shearing forces, consequential on a given state of oscillation, is a comparatively straightforward task. For further details, accompanied by some helpful formulæ, readers are referred to the paper in the "Proceedings" of the Institution of Civil Engineers mentioned above.

In calculating impact allowances, only the effect of locomotives need be considered, and the dynamic influence of the train which follows can be safely ignored, since it merely tends to damp down the oscillations set up by hammer-blows. The tender, passenger coaches, or goods wagons, constituting a train, consist of loads which are mainly spring-borne, but, unlike a locomotive, they move with comparative freedom on their springs. As the train comes on to a bridge, this spring movement prevents this additional live load from having any appreciable effect in altering the natural frequency of the bridge, but it provides some small additional damping which has a beneficial influence. If the impact allowances imposed take no heed of this advantage, they will only err to a very small extent, and the error, such as it is, will have the merit of being on the side of safety.

For a single track bridge, if the span is sufficiently long, the impact allowances must be worked out on the assumption of two locomotives having their hammer-blows in step. For a double track bridge, the case of a pair of locomotives on each track, passing one another at the centre of the span, has to be considered, but the probability of the four hammer-blows, having the same frequency and being exactly in step at this instant, is so infinitely remote that full allowance need hardly be made for this most improbable combination of circumstances.

In the case of a double track bridge, if the hammer-blows of the locomotives on the two tracks are antiphased, the bridge will be subjected to torsional oscillations. It can be shown, however, that the dynamical stresses thus induced are likely to be considerably less than those developed when the hammer-blows on the two tracks are in step, and consequently, in prescribing impact allowances, the problem of torsional oscillations need not be studied.

* Abstract of paper read before the Institution of Structural Engineers, October 27th.

Electric Ship Propulsion Systems and Control.*

By G. O. WATSON, Control Gear Engineer, B.T.H. Company Ltd., Rugby.

Much has been written around the economics and advantages of electric propulsion of ships, but very little has been published in reference to details of systems and control apparatus, and a few notes on this side of the problem may be opportune. I therefore propose to outline some of the systems of control hitherto employed, and then to deal with alternative methods of achievement.

As a general rule, the propulsion equipment of British-built ships must comply with the requirements of Lloyd's or British Corporation Surveyors. Neither of these bodies has so far published any definite set of rules on the construction of propulsion control gear, for the guidance of owners and builders, and each manufacturer has therefore been left to obtain approval of his own particular scheme and apparatus. This, without doubt, is sound, and although electric propulsion is well past the experimental stage, manufacturers should not be tied to hard-and-fast rules which preclude the adoption of new ideas.

On the other hand, competition between manufacturers is beginning to be felt, and there must be no slackening in the very high standard which has earned success to pioneer efforts. For had those earlier pioneer ships, such as the "Jupiter" (American-built in 1913), the "San Benito" (British-built in 1920), and later the "Viceroy of India," not been such unqualified successes, electric drive would not be in its present strong position. Not the least important of its attributes is the question of reliability, and any doubts which may have existed on this score have long since been dispelled. It will therefore pay us to study some of the principles underlying the construction of these early equipments and experience gained from them.

Turbo-electric and oil-electric equipments have little in common, and can therefore be dealt with separately.

Turbo-electric Equipments.

These have been almost entirely A.C. schemes, though

* Rugby Engineering Society, Nov. 9th, 1932. Abridged.

there have been a few small equipments using D.C.

Most of the early equipments used induction motors, commencing with that pioneer ship the U.S.A. airplane-carrier "Langley" (formerly the collier "Jupiter"), installed in 1913. Synchronous motor drive was first introduced in 1920 in the "Cuba" and "San Benito." Up to January 1st, 1932, seventy-three turbo-electric ships had either been commissioned or were under construction, totalling 1,153,300 S.H.P. Of these, the G.E. Company, of Schenectady, and its associated companies, including the B.T.H. Company, had supplied 1,012,400 S.H.P., or 88 per cent. of the total. These include two U.S.A. airplane-carriers of 180,000 S.H.P. each, and the new French superliner of 160,000 S.H.P. From these we drop to the 28,000 S.H.P. of the "Strathnaver" and "Strathaird," the largest electrically propelled merchant ships afloat. These figures enable one to visualise the present position and the size of plant with which we are dealing.

In practically every case the turbo-alternator supplies the propulsion motor only, *i.e.*, it does not supply any auxiliary load. This has an important bearing on the question of control, and it gives a free hand in control and protection, as will be seen later. On the other hand, isolated cases have been dealt with in which auxiliary load has also been carried. In these cases the range of speed over which the alternator can be varied is limited, and instead of switching off the alternator field before reversing, the line contactors for stopping and reversing must be opened and closed under load. Also it is necessary to use induction motors for the propellers and obtain the lower speed ranges by resistances in the rotor circuit. An exception must be made of the "San Benito," "Musa," and "Platano," wherein the main circulating pumps were supplied by the main turbo-alternators. The "Musa" and "Platano" pumps had two motors in tandem—one A.C. and one D.C. The D.C. motor served to run the pump for starting, and when running at low turbine speeds. The A.C. motor was switched on direct by hand, automatically cutting out the D.C. motor. Similarly the D.C. motor automatically notched in again when the A.C. motor was tripped out.

Ignoring these special cases, the normal method of control is as follows :—

Induction Motor Drive.—Reversing is accomplished by contactors which reverse two of the stator connections between the alternator and the motor. All switching is carried out with the alternator running at about one-fifth to one-quarter speed. Resistance is inserted in the rotor circuit to facilitate starting, and is short-circuited before increasing the turbine speed, this being safeguarded by suitable interlocks. This system is less efficient than synchronous motors, and is only used where the latter would be unsuitable. On the other hand, the power wasted in resistances is a small proportion of full power, as they are only in circuit at slow speeds. As the H.P. varies approximately as the cube of the speed, it will be seen that at a quarter speed the power is less than 2 per cent. of full power. The resistance usually consists of monel metal strips in suitable tanks, cooled by circulating sea water from the condenser circulating pumps. Stator contactors and cables will require to be slightly larger with this type of drive, as compared with synchronous motor drive, on account of the lower power factor. The synchronous motor usually operates at around unity P.F. Change-pole motor are sometimes employed in order to give an efficient cruising speed.

Synchronous Motor Drive.—This is the more usual, and generally the most efficient, form of motor, and will therefore be dealt with more fully.

The motors are of the salient pole type, having a high-resistance squirrel-cage winding embedded in the pole faces of the rotor. Reversal of rotation is by means of stator contactors, which can only be opened or closed when the field current on the alternator and motor is switched off.

To start the motor the stator contactors appertaining to the required rotation (*i.e.*, whether ahead or astern), are first closed. The alternator will be rotating at about quarter speed. The alternator field is then switched on at about double the normal strength. There are various alternative means of obtaining this extra excitation, which will be described later, but the object is to produce and maintain a suitable alternator voltage under what is practically a short-circuit condition. The D.C. winding on the rotor of the motor is not excited at this stage, and the motor starts up as a squirrel-cage induction motor, and will accelerate under these conditions to within a few per cent. of synchronous speed. When the engineer observes by means of his tachometers that the motor is up to speed, he closes the motor field contactors and the motor pulls into step as a synchronous motor. The alternator field is then reduced to normal, and the speed adjusted as required. These are the normal starting operations, and we may now consider in detail the control equipment.

The speed of the propeller is controlled by varying the frequency by control of the turbine speed. This requires a long range governor of special design the setting of which can be varied. The remote control of the setting has been done in various ways, such as by solenoids, electric motor, or hydraulically by oil pressure. The method employed by the B.T.H. Company is by direct mechanical coupling to a pilot valve. The lever controlling the setting is located alongside the other manœuvring levers, and is interlocked with them mechanically, so that manœuvring can only take place at low speeds. One reason for this is that this system exerts maximum reversing torque at about one-fifth to one-quarter speed.

The extra excitation required on the alternator can be obtained in the following ways :—

(*a*) By using a three-wire D.C. system and connecting across the outers for starting, and then transferring to neutral. This system is practically universal in U.S.A. It involves four main field contactors as against two with other schemes. Also a main field regulator as against exciter or booster field regulator.

(*b*) An exciter, the voltage of which can be temporarily doubled. It must therefore handle four times the normal kilowatts during manœuvring.

(*c*) A booster to give the additional voltage required. This can also be used in normal running for adjusting the excitation for power factor correction.

(*d*) Series-parallel connection of the alternator field winding (B.T.H. patent application 426/32).

A balancer set is sometimes used when the supply voltage is unsuitable for the alternator or motor excitation to obtain, say, 110 volts per machine with 220-volt bus-bars.

Excitation will usually be obtained from the ship's D.C. bus-bars. It is then necessary to ensure a continuity of supply. A vessel, such as the "Strathnaver" has D.C. plant consisting of one 450-kW and three 750-kW generating sets representing an aggregate of 2700 kW, which is distributed to all corners of the ship. In addition to essential services, such as steering, navigation lights, pumps, forced draught fans, and excitation, there will be a considerable "hotel" load, such as cooking, fans, lighting, lifts, &c. The switchboard is therefore divided into preference and non-preference circuits. When the predetermined load on the generators is passed, the non-essential circuits are instantly tripped, leaving the preference circuits. The latter are again subdivided, some with a five-second and others ten-second delay. If the overload on the generators persists, these are tripped in turn. Excitation can be further safeguarded by arranging that the feeder circuit breaker and the starters for exciters or boosters do not depend on solenoids for continuity of supply. The plain knife switch type of starter and a circuit breaker without low-volt trip are therefore preferred. If required for interlocking or protective purposes, a trip coil can be fitted, which is normally de-energised.

In twin, triple and quadruple-screw equipments where there is more than one generating unit, transfer and isolating switches will be required. It is not usual to parallel the alternators, and interlocks are necessary to guard against a combination of switching which would do so.

For protection purposes, several systems have been used. The important facts to remember are that, first, power supply should not be interrupted unless it is absolutely necessary, and, secondly, that the motor becomes a generator if the ship is travelling at speed and the power supply is cut off. In view of the first requirement, it is usual to deal separately with earth faults and short circuits or open circuits. A single earth on the system does not call for immediate interruption of power. One method is to earth the neutral of the generator through a limiting resistance, a relay, and a circuit breaker. Values must, of course, be selected so that an earth near the neutral will operate the relay and at the same time restrict the fault current of an earth at full potential. In the event of a fault to earth, the fault current operates the relay which trips the earth circuit breaker, thus breaking the artificial earth connection and at the same time operates warning devices, but does not interrupt power. Provided there is only one earth, the engineers can reduce power in order to reduce the voltage and so diminish the risk of further trouble until a suitable opportunity presents for further investigation. Provision is also made to cut out the audible alarm, but not the visual alarm.

Short circuits and open circuits (resulting in single-phasing) must be treated on a different principle, in order to avoid destruction of the plant. This is usually taken care of by one of the many systems of balanced protection, such as a system of relays which operate if the current in the three phases is unbalanced or if the current in the neutral leads of the motor and alternator are unequal.

Oil-electric Equipments.

Whilst A.C. is almost universal for turbo-electric equipments, the reverse may be said of oil-electric; in fact, there have been only one or two isolated cases of A.C. Among these honourable mention must be given to the first electric drive in the British Isles (apart from submarines), viz., an experimental launch, the "Electric Arc," of 1911, which had a 35 H.P. A.C. motor, with change-pole motors, which was quite successful.

Owing to the fact that numerically the majority of oil-electric equipments have been in tugs, ferry boats, fire floats, &c., of comparatively small displacement, it is not possible to record with certainty the aggregate number and S.H.P. in service. The first commercial application was made in 1913 in the British-built "Tynemount," of 500 S.H.P. The first large equipment in any country was the "La Playa," 2500 H.P., four-engine fruit ship, equipment by the B.T.H. Company in 1924. The largest equipments to date are the "Courageous," by the G.E. Company, Schenectady, having a 4000 H.P., 60 r.p.m., 1500-volt motor, and the Italian train ferry "Scilla," which has a total engine capacity of 6600 H.P. The number of oil-electric equipments in existence is probably of the order of 200, averaging about 800 S.H.P. each. There is no technical reason why Diesel-electric drive, with either A.C. or D.C. motors, should not be used up to any capacity required, but it is only proposed in this paper to deal with existing equipments, which, as already stated, are almost invariably D.C.

The advantages of the oil-electric drive are best realised in a multi-engine equipment, in which the generators are connected in series. The propeller load varies approximately as the cube of the speed. Therefore, if it is required to run at less than full speed, we must either strengthen the motor field or lower the voltage. The former would involve a larger motor, so the latter method is preferred. Having the generators in series means that as the speed and load is reduced, one or more of the engines may be shut down. In order, however, to make full use of the lesser number of engines, the motor field must be weakened to enable the generators to be fully loaded. This will be better explained with an example. Taking a four-engine equipment, this will give full load and speed with full voltage and full motor field. Now cut out two engines, and the voltage is reduced to half, the generators being in series. But half voltage would only give half speed, which only requires one-eighth of full power, whereas the two engines are capable of doing half power. By weakening the motor field, we can increase the speed to 79·5 per cent. of full speed with two engines, the generators being fully loaded at full voltage.

All equipments to date have been regulated on the Ward-Leonard principle, viz., by regulating the speed by generator voltage, the engines being run at constant speed. Some of these schemes also introduce relays which give, in effect, a constant current characteristic. For instance, in an icebreaker the propeller may become fouled, and it is necessary to introduce current-limiting devices to increase the torque, but to limit it to a safe value, even if the propeller stalls. Another system which will shortly be installed uses the constant-current principle, but varies the magnitude of the current at various speeds.

It is usual in oil-electric equipments to provide for bridge control, all starting, stopping, and reversing of the propeller being done from the deck. This can be done in a variety of ways :—

(*a*) By a rheostat or controller operated direct, relying on the operator to observe an ammeter or depending on the time lag in the field system.

(*b*) By a rheostat or controller operated through the medium of a spring with a dashpot to introduce time lag.

(*c*) By introducing gearing to bring about a time delay.

(*d*) By motor-operated rheostats with a follow-up scheme, so that the operator moves a master controller and the motor-operated rheostat follows up at a predetermined rate and stops at the corresponding point.

(*e*) By direct operated rheostat in conjunction with an automatic regulator working on the voltage of an exciter or booster to automatically regulate the rate of acceleration.

If constant current features are provided, a direct-operated rheostat or controller is sufficient, as the system is self-protecting against overloading. It is usual to provide an alternative engine-room control for emergency purposes, in case of any accident which might put the bridge control out of action.

With the motor-operated rheostat it is possible to introduce systems of load and time control. For instance, on the "La Playa" equipment the rheostat-operating motor runs at constant speed in both direction, but an over-current relay is inserted, so that if the acceleration of the propeller motor is too rapid, causing excessive currents, the relay functions and stops the rheostat motor temporarily until the current drops. In the "Brunswick," "Winkler," and "Permian" a different system is used, introducing a time element. The speed of the operating motor is varied according to the position of the rheostat and direction of running. The most suitable speeds will, of course, vary for different ships, but for these particular equipments the speeds were set to give the following :—From the full-speed position in either direction to "stop" in 10 seconds; from "stop" to half-speed position, 7 seconds; from half speed to full speed, 28 seconds. Actually, the speed of the operating motor is changing the whole time, except when moving towards the "stop" position. Moving from "stop," it starts off at maximum speed, and gradually slows down. The object of this is to load the engines at a uniform rate. As already stated, the propeller load varies as the cube of the speed. Therefore, the load increases much more rapidly when approaching full speed. Thus, half speed in 7 seconds brings us up to one-eighth power, and from half to full speed in 28 seconds adds the remaining seven-eighths, bringing us to full power.

When stopping or reversing, the ship tends to maintain the speed of the propeller at approximately 70 per cent. of its original speed, diminishing, of course, as the ship slows down, and this causes regeneration, which must be absorbed in electrical losses and engine friction. It is therefore advisable to provide the engines with liberal fly-wheel effect and good operating governors.

Another effect to be considered, especially in equipments having three or more engines, is the possibility of reversing the rotation of the engines. As soon as an engine ceases to drive a generator, owing to any failure on the part of the engine, fuel supply, &c., the remaining generators continue to circulate current through the fading generator and exert a reversing torque on the engine. It is therefore advisable to provide some form of under-speed protection which switches off the field of the generator, at the same time sounding an alarm to warn the engineer. If the engine picks up again, it is only necessary to re-close the field circuit, but if it fails entirely it should be cut out of circuit.

For overload protection it is desirable to protect against electrical faults only and to allow a wide latitude for ordinary working loads. When labouring in heavy seas the load may fluctuate widely and current-swings up to 150 per cent. are commonly experienced in some equipments. Prolonged overloads of this nature cannot prevail, owing to the lack of overload capacity in the oil engine. The overload relay can therefore be set well above the working load and have instantaneous trip. It can operate on the excitation supply, thus dispensing with main circuit breakers, and should be interlocked, so that it cannot be reset without first bringing the controls to the stop position. Earth protection is similar to that used on A.C. equipments, consisting of a circuit breaker in series with a limiting resistance and operates warning devices without interrupting supply.

In the largest equipments the voltage to earth may have to be limited by an "in and out" connection; that is to say, two or three generators in series, then a motor armature, then more generators, and another motor armature. One point in the system is earthed and the potential at other parts of the system is either above or below earth.

No special meters are necessary for oil-electric equipments, but they should be robust and suitable for the vibrations usually experienced in this type of engine-room.

The Calcutta Improvement Trust recently considered the question whether a roadway of 60ft. would be sufficient for the proposed New Howrah Bridge. The decisions arrived at were: (1) the Board was unanimously of opinion that it would be better to adopt a 60ft. roadway than to delay the construction of the bridge; (2) the Board, with two dissentients, was in favour of adopting an 80ft. roadway, if feasible; (3) the Board was agreed that if a 60ft. roadway was adopted, it must be an open roadway, without any central girder or other obstruction, dividing it into two 30ft. roadways; (4) the Board was divided in opinion as to whether an 80ft. roadway divided into two 40ft. roadways would be preferable to an undivided 60ft. roadway, the votes being six in favour of 60ft. roadway and four in favour of two 40ft. roadways.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

INTERNAL COMBUSTION PUMPS.

SIR,—During my convalescence abroad, following a surgical operation, there was published in THE ENGINEER an article headed "The Christie Two-stroke Gas Displacement Pump." My attention has only now been called to this article, although it was published in May of this year.

Every essential feature of the pump described, including the particular two-stroke cycle, the disposition of the relative parts, the vertical division in the combustion chamber, with the admission valve on one side and the exhaust valve on the other, are all taken direct from my patents, and the pump is just as much a "Humphrey pump," as the well-known pumps operating at the Chingford reservoir.

Any pump in which a column of water moves outwardly in a play pipe under the action of an ignited combustible mixture and a column of liquid returns, under the head or pressure to which the liquid has been raised, to compress a fresh combustible charge, is a "Humphrey pump."

Further, my patents cover the substitution of a solid heavy piston for the water column, and many pumps of this kind were constructed and operated.

The small company which was formed to develop the Humphrey pump came to grief as a result of the war, and the cancellation of a big contract with the Egyptian Government for what would have been the largest pumping station in the world. Consequently, like many other inventors, I made no money from my inventions, but there remains the one consolation that I have given my name to a class of internal combustion pumps, of which more will certainly be heard in the future, now that my patents have run out.

Quite recently the application of my pump to ship propulsion has been re-invented by one who was ignorant that my patents dealt with this subject; and in another direction a Frenchman has re-invented the solid heavy piston air compressor. During the war I worked out a special application of the latter for producing nitric acid by the Hausser process, and a secret patent was taken out for it in my name by the Government in many countries.

Several well-known engineers have recently approached me to ascertain if there is any obstacle to the manufacture and use of my pumps, and I have been glad to assist them with descriptions and data, and given their suggested efforts my blessing. I am equally pleased to see Mr. Christie devoting some energy to the two-stroke type of Humphrey pumps, and congratulate him on his success. Possibly he was not to blame for the title of your published article.

H. A. HUMPHREY.

London, S.W.1, November 9th.

THE SALVAGE OF SHIPS.

SIR,—I was very interested in reading the article regarding the "Salvage of the Submarine 'M 2'," written by Captain D. J. Munroe, C.M.G., R.A., and, after very carefully going through same, I could not let the article pass without a few comments.

The whole of the article is full of what I would term "inaccuracies"—that it would appear to have been written solely from hearsay.

The main point that I object to is where he explains that the operation of lifting the German men-o'-war sunk at Scapa Flow was a comparatively simple operation.

Seeing that the ex-German ships had lain in Scapa Flow for six years before anyone attempted to tackle the job, and—having spent nearly half a million pounds in lifting the ships that I have lifted—the job could not have been quite so simple as Captain Munroe states, unless, of course, we were very foolish in the methods we adopted.

I am having the honour of giving a lecture to the Institution of Mechanical Engineers, Storey's-gate, Westminster, on December 2nd, and, if Captain Munroe would care to listen to my version of the work in lifting these ships, I think I could manage to send him an invitation to be present, and I have no doubt that he may change his mind after hearing what I have got to say.

The question of salvage work is purely a case of dealing with every individual ship in an individual manner. There is no "cut-and-dried" system which will hold good for all salvage work.

Seeing that I have lifted thirty-two ships, which includes the largest in the world, and also the deepest in the world, I feel that I am competent to write in the manner that I have done.

E. F. COX,
Managing Director,
COX AND DANKS, Ltd.

168, Regent-street, London, November 15th.

PARKGATE BRIDGE, DARLINGTON.

FOR a number of years there has been considerable congestion in the roadway under Parkgate Bridge, which carries the L.N.E.R. main lines over a roadway, known locally as "Parkgate Cut," to the north of Darlington Bank Top Station, and is the main access from the centre of the town to the Eastbourne and Neasham-road districts, and is also the main road to Yarm and Stockton. The width of the old roadway through the bridge, including a footpath at both sides, varied from 31ft. 2in. to 40ft. 3in., and widening and improvement works now being carried out will increase the width to 70ft., giving a road 45ft. wide and a footpath at each side 12ft. 6in. wide.

The south abutment of the old bridge is being retained and the extra width provided on the north side. To do this it has been necessary to construct the new north abutment in trench, over which the railway tracks are carried on temporary girders supported on timber cribs. Work on the eastern half of the bridge was begun in September, 1931, and has been completed. The reconstruction of the western half is now in hand, but it will probably be six months before this section is ready to be brought into use, after which retaining walls to the widened approaches and the road works will have to be carried out.

The dismantling of the old girders and erection of the new superstructure is being carried out in ten stages, six in the eastern section and four in the western. Each of these stages entails the closing of the roadway and one or more tracks of the railway for a period of forty-eight to sixty hours. The weight of the steel work in the superstructure of the new bridge is 700 tons.

John Lant, Ltd., Newcastle-on-Tyne, and the Furness Shipbuilding Company, Ltd., Haverton-on-Tees, are the contractors for the bridge works.

Railway Development for China.

THE pressing need of China for the promotion and encouragement of its national development—agricultural, commercial, industrial, social and political—is a network of railways to provide ample facilities for transportation and intercommunication throughout all parts of that vast country. Of special importance in the establishment of such a railway system is low cost of construction, but with a uniform gauge to permit free and flexible movement and interchange of rolling stock and freight. Narrow-gauge lines have been proposed on the score of cheapness, but analysis of the narrow gauge situation shows that the saving in cost, as compared with light railways of standard gauge, is very small. Any advantages—and they are few—are far outweighed by disadvantages in cost, delay and inconvenience incident to transfers at points of break of gauge, and the serious restrictions upon intercommunication and rapid movement for both commercial and military purposes.

Railway development in China by private capital is desirable; in fact, no other method is practicable under present financial conditions. But while adequate return on private investment must be allowed, the Government should exercise some degree of supervision and control, both as to operating conditions and financial affairs.

The above is the gist of the conclusions presented in a report made to the National Construction Commission—established by the Government of China—by Mr. Arthur M. Shaw, an American engineer, who has been technical adviser to the Commission. While present conditions are far from favourable to railway construction or commercial developments, these conditions cannot be assumed to be permanent, and development of China, though long delayed, must come in time. It is pertinent, therefore, to give a review of this official report on a railway policy for China.

To answer the frequent suggestions that narrow-gauge lines would assist in meeting the present situation, attention is called to these points: (1) The insignificant saving in first cost, as compared with a light railway of standard gauge; (2) the restrictive effect of a narrow gauge on cost of working the line, and (3) the serious obstruction to traffic flow at points of break of gauge or connection with lines of different gauge. The gauges suggested are usually the metre gauge, 3ft., and 3½ft., but comparative estimates for a line of 150 kiloms. show a cost of 38,122 dollars (Mexican) per kilometre for a standard-gauge railway of light construction, and 37,485 dollars for a similar line of narrow gauge, or a saving of only 637 dollars per kilometre to offset the very serious disadvantages. The conclusion is that the present Chinese standard gauge of 4ft. 8½in. should be adhered to, except for the rare cases where substantial and certain advantages can be shown, and where the objections can be reduced to the minimum.

In type of construction it is recommended that all new lines should be of the light or intermediate types, with rails of 35 lb. to 45 lb. and 60 lb. to 75 lb. weight respectively, excepting those lines which would have immediate heavy traffic and would require rails of at least 85 lb. per yard. A great economic advantage of such a programme of policy is that a light railway may be converted to standard or heavy construction at a very small increase in ultimate cost. Thus, it will be practicable to build a line of given length for less money, or to build a greater length of line and serve a greater area and population with a given investment. In addition, the light rails and other material released in rebuilding a line when traffic requires it, will be available for building new lines of light construction.

Reasonably good alignment is important even for light railways, while heavy gradients may be more objectionable for such lines than for heavy traffic lines on which powerful locomotives may be provided to meet special conditions. But there are many expedients that will reduce the initial outlay and yet will not materially add to the ultimate cost of the revised and improved line. Broken gradients that would be unsuitable for long trains running at high speed, are not objectionable for short, slow trains, and may be so planned as to be corrected when high-speed trains are necessary. Pile and timber trestle bridges can be so constructed as to permit the addition of extra piles or posts and additional longitudinals when necessary. For large bridges, the piers and abutments should be suitable for heavy loading; the spans may be light if early increase in traffic is improbable, or they may be built for heavy loading if it appears that such service may be required in the near future.

A width of 4·40 m. at formation level—or, say, 14ft. 6in., with 6in. of ballast under the sleepers—is recommended. But ballast may be omitted and the line packed only with the local earth or sand, as on some lines of light construction in the United States and in South America. Curves of 230ft. to 260ft. are quite practicable, and can be operated at speeds as high on standard gauge as on narrow gauge, while with higher radii the factor of safety at equal speeds becomes increasingly favourable to the standard gauge.

A Government-owned and Government-operated railway system is considered undesirable, and, in fact, not feasible under present financial conditions and the existing tremendous demands upon the funds and credit of the nation. If private capital is to be interested, a sufficient inducement in return on the investment must be offered, and this can best be secured through private ownership and management. On the other hand, the railways must not be exploited solely with regard to the profit on private capital. Therefore, there should be some Government control and a Government-supervised system of accounting, but with as little Government interference in railway affairs as is consistent with care for the interests of the public and the nation. It is pointed out in the report that as a private investment, a privately owned railway, operating under a minimum of Governmental supervision and restriction, is more efficient than a railway which is owned and operated as a Government enterprise. That this is so, is shown by experience in many countries.

As to economic conditions, Mr. Shaw compares China with other countries on the basis of miles of railway per 100,000 people, multiplied by the density of population. The comparison thus made is shown in the following table:—

Railway Conditions in China and Other Countries.

	Miles of line per 100,000.	Population per square mile.	Miles multiplied by population density.
China (exclusive of Mongolia and Tibet)	2	225·00	450
Siam	9	45·00	405
Russia	26	17·80	463
Australia	404	1·85	747
Canada	378	2·60	983
India	11	176·00	1,936
New Zealand	254	12·70	3,226
Japan	12	402·00	4,824
Spain	48	109·00	5,232
United States	261	35·00	9,135
Italy	31	352·00	10,912
France	64	193·00	12,352
Switzerland	78	243·00	18,954
Great Britain	52	370·00	19,240
Germany	57	338·00	19,266

No map or list of proposed railways is submitted, but it is stated that with a stable and well-administered Government, a railway in almost any section of China would become a paying business from the start. This is illustrated by the Peiping-Hankow Railway, which did not follow established commerce routes and which was not expected to be profitable for several years, but which proved to be a profitable investment almost immediately. The economic development of the country may be expected to undergo a gradual change as modern facilities are provided, revolutionising agriculture as well as industry. Crops which are not well suited to a given section may be abandoned in favour of more profitable staples, the section being able to supply its needs of the abandoned crops from those grown in other sections. In this way there will be built up an advantageous interchange traffic, which at present is practically non-existent, each section having to meet all its own needs. With cereals especially, the shipments in small boats will result in concentration, with a better transportation service and more economical handling.

ZIRKEL ENGLISCH SPRECHENDER INGENIEURE.

IN view of the signal success of the Engineers' German Circle in London, a sister society, called "Zirkel Englisch sprechender Ingenieure" has been founded in Berlin by members of the Verein deutscher Ingenieure. The aims of the "Zirkel" are similar to those of the E.G.C., *i.e.*, to promote the knowledge of technical English among German engineers by arranging English lectures, discussions and conversation, and to further and develop personal contact and friendship between engineers of English-speaking countries and German engineers.

The Institution of Mechanical Engineers, the American Society of Mechanical Engineers and the Verein deutscher Ingenieure are sponsors to the young Zirkel, which, at its very start, already counts over seventy members.

The first meeting of the "Zirkel Englisch sprechender Ingenieure" will be held on Thursday, November 24th, at 5.15 p.m., in the Engineers' Building in Berlin, when Mr. Loughnan St.L. Pendred, Editor-in-Chief of THE ENGINEER, will lecture on "British Pioneers of Transport." The lecture will be illustrated by slides and cinematograph films. The subject is of great international interest, particularly in view of the Trevithick Centenary, to be celebrated next April.

The further programme of the Zirkel so far includes the following lectures:—

Dr. S. J. Davies, King's College, London, "High-speed Oil Engines: Their Characteristics and the Tendencies of their Development."

A. P. M. Fleming, director, Metropolitan-Vickers Electrical Company, Ltd., Manchester, "Problems of Industrial Research."

H. B. Peirce, representative, General Electric Company, Schenectady, Berlin, "Electric Ship Propulsion."

Aubrey Smith, chief engineer, the Vacuum Oil Company, London, "Lubrication."

H. N. Wheaton, Associate Professor, z.Zt. Berlin, "The Hoover Dam."

Members of the British engineering societies intending to visit Germany are invited to inform the Secretary of the "Zirkel Englisch sprechender Ingenieure," Herrn Dipl.-Ing. W. Parey, Ingenieurhaus, 27, Friedrich Ebertstrasse, Berlin, in case they should be coming to Berlin. The Zirkel will be very glad to invite them to the meetings, and to bring them into contact with German engineers.

Railway and Road Matters.

THE fact that it was eighty years ago on the 14th of last month since King's Cross terminus was opened does not imply that that was the entrance of the Great Northern Railway into London. The latter event occurred on August 5th, 1850, when trains began to run from a temporary station at Maiden-lane. At Peterborough the new line joined the line from Lincoln, which had been opened on October 17th, 1848.

As from November 13th, the street traffic signals along Oxford-street and at the junction of Sloane-street and Pont-street are, as an experiment, having the intermediate exhibition of an amber light between the red and green dispensed with. That originally was provided as a warning to drivers that a change was about to be made, but its effect has been that a move is made as soon as red changes to amber, without waiting for the green.

THE "Manxman," the L.M.S. Railway's 3¼ hours' express from Manchester to London, established a remarkable new speed performance recently by running the 177 miles from Wilmslow to Euston in 164 minutes, inclusive of two minutes' delay. The 82¼ miles from passing Rugby to stopping at Euston were covered in 71 minutes at an average speed of 69·7 m.p.h. The train of eleven coaches, weighing 323 tons, was hauled by "Royal Scot" class engine "No. 6167," driver A. Miller and fireman A. Lennarddo, of Longsight, Manchester.

A VERY satisfactory report on street traffic signals in London was made by Mr. Pybus when answering a question addressed to him on November 2nd. He said that there were traffic control signals in operation at thirty intersections in Greater London, eighteen of which were included in the Oxford-street scheme. Light control signals required an authorisation under the provisions of the Road Traffic Act, 1930, before they were brought into use, and that was only issued when he was advised that the signals were in appropriate positions. He had received reports as to the installations which had been in use for some time, and they showed that the signals were proving themselves efficient in operation and of considerable value from the point of facilitating traffic and ensuring safety.

THE Interstate Commerce Commission's accident bulletin for the calendar year 1931, shows some very interesting figures. When compared with twenty years ago, it is seen how the provision of signalling, better track equipment and greater attention to maintenance and renewal have improved the safety record, whilst, if a further comparison be made with ten years ago, the influence of decreased business is very manifest. In the year 1911, one servant in every 458 was killed, one trainman in every 192, and one passenger in every 3670. In 1921 the corresponding figures were one in every 1160 servants killed, one in every 451 trainmen, and one in every 5096 passengers. During 1931 these figures had been improved to one in every 1907 servants, 810 trainmen, and 13,095 passengers. Only four passengers were killed in train accidents last year, but 92 servants lost their lives therein.

FIVE platelayers were run down and killed on the London, Midland and Scottish Railway near Watford on the morning of November 9th. There are four lines of way at this point, and the gang of fifteen men were working on the up slow road. There was no fog. A train had passed on the up fast line and it would appear that its smoke hid the men's view of the train approaching on the up slow. A look-out man was protecting the operations, but he was so overcome by shock that he was still in hospital, so could not give evidence at the coroner's inquest on the 11th; but a statement made by the man was read in which he said that he had previously given a warning that the up slow signal was "off," by four blasts on his whistle and shouting. The jury returned a verdict of accidental death, with a rider that the company should install a more efficient system of signalling. As the Ministry of Transport is certain to hold an inquiry there is little need for us to comment on this rider, except to say that one of the successful activities of the Railway Employment Safety Appliances Committee was the drafting of rules on this very question. It must also be added that Rule 273 lays down: "When a train is approaching, men at work on the permanent way must not remain on any running lines, nor between them if the spaces are less than 8ft., but must at once move clear of all lines unless they can distinctly see that they are in a position of safety and in no danger from another train approaching them unobserved.

HEREIN on July 15th we recorded that on the 8th of that month, a London and North-Eastern passenger train, when ascending the 1 in 39 to 1 in 49 gradient that comes at the end of the connection from the Metropolitan Railway, came to a stand owing to excessive slipping. The train then ran back and was derailed at some catch points that protected the line from the London, Midland and Scottish Railway. Six coaches were derailed, the rear van of which fouled the line from the L.M.S. Railway, and it was run into by one of that company's goods trains. The accident was inquired into by Colonel Anderson, whose consequent report was issued on the 3rd inst. Of the conditions to be contended with in the tunnel to the L. and N.E.R. it will suffice to say that the report records that the rail was greasy and the atmospheric conditions were very bad. At the time of the accident the tunnel must have been full of smoke and steam from a succession of hard-worked engines which was added to by the slipping of the engine. Even breathing is at times difficult, and drivers have little or no chance of detecting and rectifying any error such as the man on this occasion made, and only by touching the tunnel lining with an outstretched hand can trainmen be certain that they are travelling in the right direction. The error made by this driver was that, at some moment, when struggling against the slipping, he had reversed the engine and failed to notice it. Colonel Anderson recommends an improvement in the catch points, which should lead to a sand drag, an extension of a track circuit, and the provision of lights in the tunnel. He also observes that nothing short of electrification of the tunnels at this point can make the atmospheric conditions really satisfactory.

Notes and Memoranda.

ACCORDING to an official report, there are now in this country about 19 grammes of radium. This amount, together with its necessary containers, has cost £217,937.

IT has been found that anodically treated aluminium upon which has been scattered copper arsenide will not deter barnacles from attaching themselves to floating craft, but covering the part with cellulose, and then with copper arsenide, seems to be a fairly complete protection against barnacles.

AN engineer of the Japanese Government Railways, Mr. T. Kuroda, has devised a novel system of putting in place the girders of railway bridges which need replacement. He runs the new girder out on to the existing one and then attaches one to the other by diaphragm plates at each end. These plates are provided with trunnions. The combination is jacked up off its seating and reversed on the trunnions. It is then lowered into place and the old girder trundled away on the new.

SCIENTISTS of the Department of Mines at Ottawa have developed a distinctive Canadian formula for the extraction of radium from the Great Bear Lake pitchblende ores. After more than a year of exhaustive research, announcement is made that the chemists of the Department, who have been working on the problem of reduction of the radium ore, have accomplished the extraction by a simplified technique expected to be of great assistance in developing the Canadian radium supply. The time occupied and the chemicals required have both been reduced by about one-half, as compared with the Belgian process.

A PROCESS for the direct and rapid estimation of the free sulphur contained in liquid fuels and solvents is proposed by H. Kiemstedt. The liquid to be examined is shaken with mercury. The sulphur combines to form mercury sulphide, and is estimated by heating the mercury with concentrated hydrochloric acid, and catching the hydrogen sulphide in an ammoniacal solution of cadmium acetate, or in an iodine solution. It is stated that the test is not too reliable from the qualitative aspect, as blackening of the mercury may also be due to the action of peroxides, which frequently occur in cracked petroleum products and in certain solvents.

THE ordinary life of a 14in. by 14in. pitch pine pile in the old Ryde, I.O.W., pier was, according to Mr. C. J. Jackaman, found to be from ten to twelve years, and the Oregon piles used in the temporary staging for the execution of renovation work were found to be honeycombed to nearly 1in. in depth in from six to nine months. In an adjoining pier constructed of timber an effectual method for resisting the action of the sea worm was as follows:—Wrought iron clout nails, about 1in. long, with square heads, were driven closely together, forming, when rusted, a metal sheating, which has proved impervious to the attacks of the worm.

To meet the dual conditions of tropical temperature and operating heat, beeswax has been most generally used in the past in connection with certain manufactured articles, but more recently there have become available chlorinated naphthalene products which, waxlike in consistency, can be produced with melting points as high as 250 deg. Fah. According to the *Chemical Trade Journal*, they introduce new possibilities and economies in small coil production in such manufactures as the gramophone, telephone, radio, and similar industries. Apparatus that previously required varnish impregnation or the more complex processes of sealing, and could not utilise wax-bitumen mixtures on account of their black colour, may be treated with chloronaphthalene waxes.

THE strong incentive to obtain the highest thermal efficiency in aircraft engines has, says *Nature*, led to the manufacture and use of lead tetra-ethyl on a large scale. There is now an equally strong incentive to develop heavy oil internal combustion engines for aircraft. It is quite possible that this will only be satisfactorily accomplished if a suitable synthetic chemical compound can be found to promote the smooth combustion of oil when injected into the engine cylinder. Again, the economic success of air transport depends largely on the working life of an engine between overhauls, and this depends mainly on the stability of lubricating oil. The study of lubricants becomes more and more a chemical problem, and in future chemical engineers will have to produce them to precise specifications. One of the most vital problems of the aircraft industry to-day is that of the production of light alloys and prevention of the corrosion of metals and alloys. This is a matter of the widest industrial importance. There are many other ways in which the aircraft industry has already influenced the chemical industry. This influence is bound to persist, since the aircraft industry is not a self-supporting industry, and can only be made self-supporting by intensive scientific investigation of all its problems.

ACCORDING to the *Iron Age*, typical data taken from extended studies of many alloy-steel systems show that nickel may serve a useful *rôle* in nitriding steels. Its principal benefits are found in one or more of the following:—(*a*) Its strengthening and toughening effects upon the case with moderate decreases in case hardness; (*b*) its strengthening and hardening effects on the core by which to provide better support to the case; (*c*) its development of dispersion-hardening phenomena in steels containing appreciable proportions of aluminium by means of which articles may automatically acquire higher core strength and elastic properties during nitriding. The effective use of nickel requires that it be balanced with certain other alloying elements. A number of low-carbon nitriding steels are described in which the beneficial effects of nickel are realised. Among these are the following types:—(*a*) Steels containing about 1·1 per cent. chromium, 0·95 per cent. aluminium, 0·25 per cent. molybdenum, 0 to 5 per cent. nickel; (*b*) steels containing about 1·1 per cent. chromium, 0·4 per cent. aluminium, 0·5 per cent. vanadium, 2·5 per cent. nickel; (*c*) steels containing about 0·5 per cent. chromium, 0·5 per cent. aluminium, 0·5 per cent. molybdenum, 0·5 per cent. vanadium, and 2·5 per cent. nickel.

Miscellanea.

THE number of public filling stations for automobiles is said to be 50,000 in Germany, 78,000 in France, 99,000 in England, 19,560 in Belgium, 14,830 in Sweden, 14,650 in Switzerland, and 10,350 in Denmark.

A MODERN bakehouse, which, it is said, will produce 5 tons of bread, biscuits, &c., a day, is being built in Shanghai and will start work in the New Year. The plant, we understand, has been supplied by Baker Perkins and Co., of Peterborough. The cost of the factory is put at £75,000.

THE Soviet Institute of Applied Chemistry announces the discovery of a new method of making synthetic rubber from acetylene. The costs of the new method, it is stated, are lower than under the other method already used in some Soviet factories, which manufacture synthetic rubber with the aid of alcohol.

WHAT is claimed to be the largest rustless ingot ever tapped from an electric furnace in this country was recently cast by the Darlington Rustless Steel and Iron Company, Ltd. The ingot weighs 6 tons 3 cwt. Ingots of approximately this size are now being cast regularly by the Darlington Company. We gave a description of the plant of the company in our issue of March 11th, 1932.

FERRO-MANGANESE is to be produced in three electric furnaces at Sestaphoni, Georgia, in the Caucasus, at some works now in progress of erection. The output is put at 50,000 tons of 80 per cent. ferro-manganese per annum at the outset, but the plant will eventually be enlarged to produce annually 150,000 tons. As there is ample and cheap water power at hand, it is estimated that ferro-manganese can be produced at a low cost from the available ore rich in manganese.

ARRANGEMENTS have been made whereby in future there will be very close co-operation between the firm of Chance Brothers and Co., Ltd., Birmingham, and the Parsons Optical Glass Company. For some time it has been evident that considerable saving in the manufacture of optical glass could be effected by pooling the knowledge of the two firms and by concentrating the production in one establishment. Under this arrangement all optical glass will be made at Messrs. Chance's Smethwick works under the joint supervision of the present manager, Mr. W. N. Wheat, and of Mr. H. C. Rands, who, under the leadership of the late Sir Charles Parsons, has been largely responsible for the development of the Parsons Optical Glass Company.

THE Imperial Oil Company of Canada reports the successful operation of a small refining plant established during the past summer at its oil well on the Mackenzie River. The company recently opened up again the oil well originally capped in 1925, as the fuel was needed for mining operations in the neighbourhood of Great Bear Lake. The wells, situated some 350 miles north of Fort Norman and close to the Arctic Circle, are believed to be the farthest north producers in the world. The oil produced this year will be sufficient for the needs of the mining companies until the 1932 season and was barged up the Mackenzie River to Fort Norman and up the Bear River to Great Bear Lake, most of the shipments being to the Eldorado Gold Mines, Ltd., for operating power mining machinery.

ON January 1st, 1933, a vehicular ferry service will, says the *Far Eastern Review*, commence running between the new Hong Kong pier and Kowloon. Three boats are being built for the service at the Hong Kong and Whampoa Docks, at an estimated cost of 1,800,000 dollars. They will have a length of 130ft. and a beam of 41ft. 6in. and will be capable of a speed of 10 knots. Each ferry will have three decks. The bottom deck will be capable of taking twelve large motor lorries and will have accommodation for third-class passengers. On the middle deck the second-class passengers will be accommodated, and first-class passengers will have space on the top deck. All the ferries will be fitted with Gardiner oil engines of the "J" type. Each will have two sets of engines and each set will be capable of developing 400 horse-power.

WITH the completion of dredging operations in the Brockville Narrows, another link has, says the *Canadian Engineer*, been welded in the St. Lawrence waterway. A channel 27ft. in depth is now available from Crossover lighthouse, 7 miles east of Sister Island, between Brockville and Prescott. The average width through the Narrows, extending from Hillcrest to Big Island, is 550ft., with a minimum of 500ft. The remainder of the channel above and below the Narrows is 750ft. wide. Dredging operations, now under way in American waters, extending from Crossover lighthouse to Clayton, N.Y., will be completed shortly. The new channel, 27ft. in depth throughout, will then extend from Lake Ontario to Prescott, making possible the navigation of the larger upper lakes by freighters from the head of the lakes to Prescott.

DURING the past week we regret to have to record two serious fires aboard ship. On Sunday morning about 3.30 a.m. fire broke out on the 5700 gross ton Blue Star refrigerated cargo liner "Oregon Star" in the 'tween deck spaces of No. 1 hold. The vessel was lying alongside Palmer's Shipyard at Hebburn-on-Tyne, awaiting reconditioning. Considerable damage was done, and despite a gallant rescue attempt made by Mr. Peter Thomson, the firm's assistant superintendent engineer on the Tyne, Mr. Vass Hamilton, the first mate, lost his life. On Monday night a serious fire broke out on the Dutch motor passenger liner "Pieter Cornelisszoon Hooft," which was lying alongside a wharf in Amsterdam harbour, after fumigating. The fire proved most serious, and almost the whole of the superstructure and the hull, with the exception of the fore part, was gutted. The question of fires aboard ship is engaging the attention of a special Board of Trade Committee at the present time, and a valuable review of the whole subject was given by Mr. E. Lealie Champness in a paper on "Fires on Ships," which he read on Friday last, November 11th, before the North-East Coast Institution of Engineers and Shipbuilders. Mr. Champness is to be congratulated on his full treatment of the subject from the point of view of the shipowner, the shipbuilder, and the insurance and underwriting interests.

THE NEW TANK AT THE WILLIAM FROUDE LABORATORY, N.P.L., TEDDINGTON

(For description see page 506).

FIG. 5—WATER-WAY FROM WESTERN END

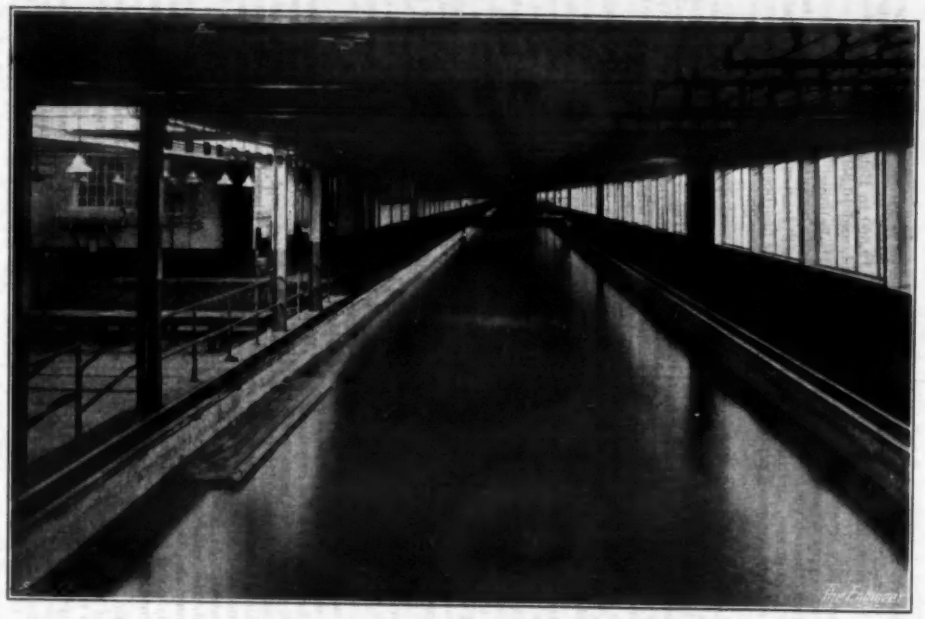


FIG. 6—WATER-WAY FROM EASTERN END

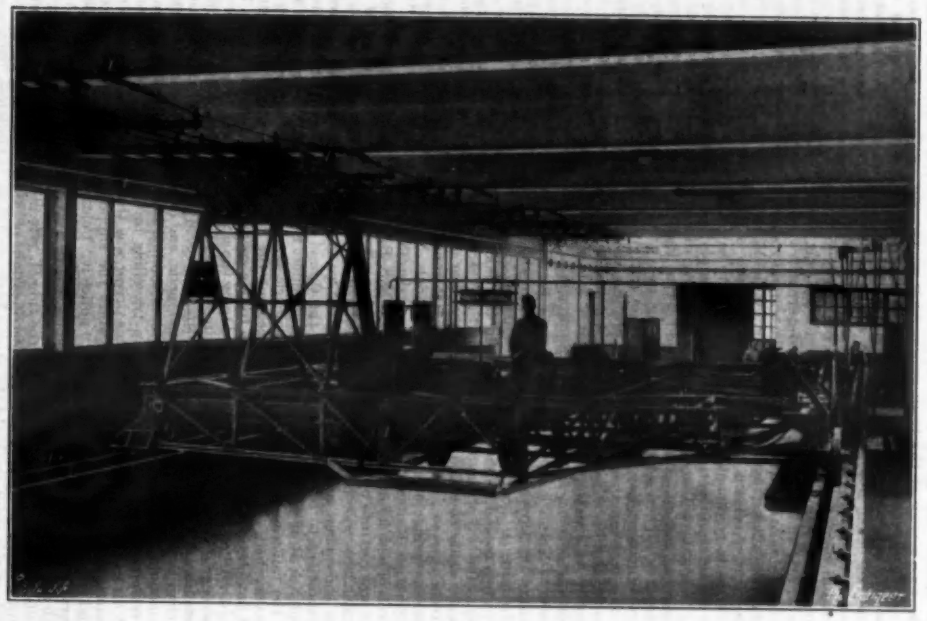


FIG. 7—TRAVELLING CARRIAGE

FIG. 8—MODEL WORKSHOP

The Engineer

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NOTICES TO READERS.

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THE B.E.A.

THERE was never a time in the history of industry when so much reliance was being placed upon co-operative efforts as the present. In the United Kingdom, which has always been characterised by individualism, unified activities are less common than in other countries; but even here they are more frequent than they used to be, and strong indications that the spirit of co-operation is extending into scientific, technical, and industrial fields are not far to seek. The reasons for this change of habit are fairly evident. The strength of an amalgamation of interests rises not only directly as the number of units concerned, but to some power of that number, so that a large confederation is in a position to secure attention to its views and wishes and may be strong enough to carry them even against considerable opposition. That is the obvious and familiar argument for co-operation. But there is yet another of almost equal weight. If a number of entities work separately and individually towards a given object, there is inevitably much duplication and waste of energy. Consider, for example, the time and money that are expended in the collection and collation of data, or, if it be a case of approaching some authority, the work that must be devoted to personal visits, correspondence and the preparation of memoranda. Manifestly, if a score of firms all want the same data, or all desire to address the same authority, great economy can be achieved by placing the whole matter in the hands of appointed officials, whose sole business it is to carry out the wishes of the group. Hence, co-operation gives not only greatly increased power, but it does so at much less cost. We take those to be the principal reasons why we find confederation so frequent abroad and why it is being regarded in this country with more favour than heretofore.

These reflections arise from an after-luncheon address which Mr. William Reavell delivered last week before the members of the British Engineers' Association. Mr. Reavell has just received the signal and exceptional honour of being elected Chairman of that Association for the third year in succession, and in his address he marked the occasion by recalling the good work for the engineering industry which the Association has done in the past, and by presenting a vision of the greater services which it may render in the future. It may be thought that the B.E.A. is already too well known to need *réclame*, but when we remember that it is not as well supported as it ought to be, we deem it worth while to lay the whole of Mr. Reavell's case before our readers, so that those who know the work of the Association may refresh their memories, whilst those who are not adherents may see for themselves the value of the services that it has and can render. An argument frequently used in support of institutions is that if they did not exist every one would desire to see them created. That is very true of the British Engineers' Association. If there were no body representative of manufacturing and commercial engineers, if there were no organisation which would serve their communal interest, if there were no one to collect and tabulate data for them and to speak on their behalf with an authoritative voice, can it be doubted for a single moment that immediate steps would be taken to establish such a body? For many years the British Engineers' Association has fulfilled those functions, and, as Mr. Reavell showed with justifiable pride, had fulfilled them well. When we consider these facts it does, indeed, seem astonishing that the support which it receives from the engineering industries is not far greater than it is. We are almost forced to the conclusion that, in a great many cases, the services which the B.E.A. performs are being enjoyed by firms which do not subscribe to its expenses and support it by their adherence. We might ask, as Sir Gilbert Vyle did when speaking on Mr. Reavell's address, if that is "quite cricket"? But a more effective argument is to our hands. We may, we hope, assume that engineers are agreed that at this time, more than any other, a representative organisation is essential. If that is admitted, is it not clear that the larger such an organisation is the better it will represent all branches of the industry, and the stronger will be its arm to secure whatever may be to their benefit? And there is so much to be done at this critical moment in the engineering industries; a moment when they are beginning to rise out of the long trough of depression, when a new weapon of untested potentialities, and possibly, of unknown dangers has been put into the hands of industry by protective tariffs; and when the promises of the Ottawa agreements have to be implemented by wise management. Surely no engineer who is engaged in commerce can fail to see that at such a time the existence of a strong, fully representative body is really an imperative necessity. There are many things that cannot be done by the single individual or the single firm, things that call for the collection and analysis of data, for the preparation of carefully weighed statements, for interviews with Ministers and Dominion statesmen, and for the expert examination of foreign policy as far as it affects our own engineering industries. We fail to see how that work, work of vital importance, can be performed without the aid of a representative institution. If such an organisation did not exist engineers would now be making haste to establish it. Fortunately, it does exist in a well-tried form, which needs no more than additional strength to enable it to wrestle successfully with the new and urgent problems of the day.

There is a passage in Mr. Reavell's speech which cannot but be read with feelings of deep regret. He spoke of an invitation received by the Association from the Parliamentary Secretary for Overseas Trade, an invitation to send a representative to Canada to further British trade in that great Dominion. And what was the reply he had to make? It was that the active support which the British Engineers' Association receives, and, therefore, the total revenue which it has, "is too small to justify the Council in undertaking the heavy financial responsibility which would be involved." That is the position to which an Association with great potentialities has been brought by the indifference of the industry it represents and supports. Mr. Reavell visualised a revitalised and extended British Engineers' Association, organised to give due representation to every section of the engineering industries, and he told his hearers that he, the Council, and the Director, Mr. David Bremner, were going to direct their energies in the coming months to the achievement of that great object. We wish them every success. The time has passed when engineers could paddle their own little canoes. Co-operation and united action are called for. The canoes must be replaced by triremes. If full advantage is to be taken of the prospects which recent events have foreshadowed all the engineers of the United Kingdom must pull together. There is great work to be done, and we trust that the British Engineers' Association may be given the power to do it.

European Engineers' Federation.

THE work of remedying the economic dislocation of Europe, like other undertakings of infinitely smaller importance, cannot be pursued without organisation. Such an organisation would be so vast that it could only be established by grouping in such a way as to ensure that the work would be carried out with an eye to the general interest, to the exclusion of local, national, and political influences. Grouping has begun on the Continent amongst industrialists and traders for the adjustment of matters affecting foreign exchanges; amongst public works contractors for co-ordinating work in order to facilitiate the carrying out of undertakings in the interest of all concerned; and amongst scientists and economists who feel that the problem is too complex to be dealt with except by close understanding with men of the highest intelligence and attainments in the different countries. Little, however, has so far been done to bring together technicians who are, after all, best qualified by their training and experience to deal with the tangled problems which have paralysed Europe and the world. An attempt is, however, now being made to group engineers into a European Federation by a Comité d'Initiative, which has been constituted in Paris under the presidency of Monsieur Yves Le Trocquer, former Minister of Public Works and author of the plan for a European Customs Union. It comprises about fifty distinguished representatives of the engineering profession and of members of the Institute. The formation of this committee was due to Monsieur A. Guiselin, Secretary of the Chambre Syndicale des Ingénieurs, who found that some Continental countries were all the more ready to adhere to a European Federation because the idea, though apparently for other reasons, had been discussed at a conference at Tokyo towards the end of 1929, when it was proposed to form a World Federation of Engineers. The suggestion was received coldly in Europe, where it was feared that the interests of Continental engineers would be submerged in an organisation which included engineers of the United States and of all parts of the world. Hence the idea of a European Federation has found favour in some parts of the Continent, while in France its constitution is regarded as absolutely essential to world prosperity, as well as to the influence and status of engineers themselves.

The carrying out of such a huge organisation, whatever may be the benefits accruing to its members, is obviously fraught with great difficulties. There must be absolute community of interest, and a total absence of any over-riding influence or partiality which might cause friction. Therefore it is impossible to determine under what conditions the Federation will be constituted, or what may be its definite objects, until all countries have been consulted and all have given their adhesion to the principle involved. The Federation may be limited to certain aims, or it may be extended to cover all matters affecting the well-being of engineers. It may be developed into a power similar to that of the International Labour Bureau, engineers in one country having their interests automatically protected in other countries. At present, there is no such protection and no international recognition of diplomas in an official sense, though German and Swiss diplomas, for example, are accepted at their own value. All these matters of general interest are, however, subordinated, at the moment, to the one great object of grouping engineers from all over Europe with the purpose of making them a power in the evolution of European economy. The recent Conference at Stresa approved the programme of public works which it is proposed to put in hand in order to enable Europe to tide over a very difficult transition period. Whether the works will give the desired result in promoting activity is another matter, and, in any case, their execution depends upon financial facilities that Europe seems little able to provide at the present moment. Nevertheless, it is assumed that there will be some activity in international construction work during the next few years, and a Federation of engineers, such as that proposed, would be able to exercise considerable influence on the elaboration and execution of plans that affect the Continent as a whole. The idea is to give to the engineer a voice in the solution

of problems that can be most adequately dealt with by men whose training, culture, and experience fit them specially for the task. As the Federation of European Engineers can only exist on the basis of a suitable representation of all the countries adhering to it, the first difficulty is to settle upon a method that will satisfy all of them. The difficulty is a serious one, for in France there are 55,000 engineers of different grades, in Spain about 10,000 engineers possessing exclusive diplomas, and in Belgium from 6000 to 7000 who can only exercise their profession with diplomas from institutions of the highest class. In some countries the engineer undergoes an intensive training; in others he may be self-trained. It is obviously far from easy to propose any method whereby all countries will feel that they have an equality of influence in the Federation, but such a method should be found if all engineers look to the main object aimed at, and it is because the whole matter must be discussed in the different countries concerned that a suggestion is put forward to create national clubs where the proposal can be considered in all its bearings and where there can be an interchange of views with visitors from foreign clubs.

Only when all countries have settled upon the general lines of the Federation, on the basis of suggestions put forward by the Comité d'Initiative, will it be possible to elaborate finally the rules and objects governing its operations. For the moment, all that can be said is that the influential Comité d'Initiative, supported by the French Government and by engineering societies, has received the adhesion of Spain and Czecho-Slovakia and is carrying on negotiations with other countries; but it is clear that engineers in all countries must discuss the scheme amongst themselves before there can be any certainty of success. In view of the services that such a Federation may render the engineering profession on an international plane, its objects are at least worth consideration.

Literature.

Industrial Psychology in Practice. By HENRY J. WELCH and GEORGE H. MILES, D.Sc. London: Sir Isaac Pitman and Sons, Ltd. 1932. Pages 249. Price 7s. 6d. net.

PSYCHOLOGY is generally regarded as the science which analyses and classifies the phenomena of the mind, but in the work before us the authors appear to have a wider conception, appreciating that body and mind are so interdependent that both must be considered together or success cannot be expected. The main desire of the industrial psychologist is rapidly to detect anything which will prevent or hinder work from being done, not only as quickly, but as easily as possible.

This book teems with contentious matter, but the authors are firmly entrenched, for when we begin to doubt the truth of certain assertions we are confronted with a mass of statistical evidence based on much painstaking and extensive research, and not only is the old adage *experientia docet* fully confirmed, but if rightly manipulated it goes further—it convinces.

The subject is divided into two main parts, the first dealing with the health of the worker and the improvement of working conditions, and the second with problems incident to the *personnel*.

In Section I. the reduction of fatigue is considered in all its aspects, and we are told in an unequivocal manner that not only are long hours uneconomical, but overtime is wasteful and eventually inefficient. With the graphs and tables lying open before us we are bound to agree in principle, even if we make a mental reservation that occasional overtime resorted to in an emergency is justifiable and not calculated to produce that over-fatigue, which is so repugnant to the authors. Curtailment of working hours may be regarded as a negative approach to the subject, but when we read that "industrial psychology has successfuly demonstrated the benefits to be gained by a systematic course of training for workers based on adequate movement study" we are on very positive ground. We must confess that in the average engineering works far too little attention has been given to this important subject. Everyone will agree that most workers make many apparently superfluous movements, but how rarely has this been followed up by an analysis of these movements with a view to reducing them to a minimum. A perusal of the excellent illustrations showing the progress that has been made in a variety of trades will probably suggest much to the observant engineer. If the work is prosecuted systematically and scientifically, increased output and reduced fatigue will result. Contrary to the generally accepted idea that monotony has no adverse effect on a certain class of operative who appears to settle down to routine work, we have proof placed before us to show that a frequent movement of workers from one repetition job to another actually leads to increased output.

Section II. has as its theme environment conditions, with considerations as to lighting, heating, ventilation, and noise. While most would agree that increased illumination of a factory is generally followed by a greater output, probably many who read this review will recall cases where an application for better lighting has been turned down on the plea of economy. Not only is good lighting essential, but the elimination of shadows, the reduction of glare, and other analogous problems deserve far more attention than they receive. It has been rightly said that noise is one of the curses of modern civilisation, yet we seem to assume that the worker must in time get "acclimatised" to his noisy surroundings, but we do not investigate what takes place during this process of "acclimatising." The authors claim that "reduction of noise has been clearly related to an improvement in efficiency or health," and the experiments made all tend to prove their contention.

Section III. concerns itself with accidents and their prevention, and Section IV. with the internal economy of the works, including planning, lay-out, transport, waste of time and material. If we pass them without comment it is because we believe that engineers generally are alive to the importance of these problems, and not with any intention of slighting the valuable suggestions therein contained.

The concluding section (V.) is engaged with questions relating to *personnel* involving the selection and training of the employee. We are glad to notice that the authors do not advocate workers being chosen by test alone or by any one means, but they maintain that a series of tests supplement, but do not supplant, a personal interview, which must always be an important factor in selection. From the statistics given it would appear that the system of combined test and interview yields the best results, but we are warned, and rightly so, that selection must be followed by training if the full results are to be achieved.

There is much in this work on which we have not been able to touch, but the numerous examples given and collected from many industries speak for themselves, and indicate the results that can be obtained by the application of the principles of industrial psychology which are so ably described. The authors are to be congratulated on their contribution to an important subject, for they have clearly demonstrated that there are many human problems which a knowledge of industrial psychology will help to solve.

Mathematics: A Text-book for Technical Students. By B. B. Low, M.A., A.M.I. Mech. E. London: Longmans, Green and Co. Price 12s. 6d. net.

THE common belief that scientific ability is a non-inheritable quality can be supported by many conspicuous examples, and on the whole must be accepted as being well founded. This book, however, may be taken as proof of the fact that the rule is not invariable, and that from time to time instances do occur in which the ability of the father is transmitted to the son. Several generations of engineers have had good cause to be grateful to Professor David Allan Low for his skill as an instructor and guide, either in person or through the medium of his books on practical geometry and applied mechanics. Mr. Bevis Brunel Low has not only followed his father in the profession of teaching—he is Lecturer in Mechanical Engineering at the Military College of Science, Woolwich—but has now demonstrated that he has inherited his parent's rare accomplishments as an expositor and author.

Of mathematical text-books designed for the instruction of engineering and other technical students many—perhaps too many—have already been published. Nevertheless, Mr. Low's book is very far from being a superfluous addition to their number. The chief difficulty encountered by most students in their study of mathematics can be traced to the fundamental fact that the subject is one of symbols which cannot easily and concisely be fully expressed in terms of ordinary speech. It is not enough therefore that the instructor should be clear in his own thoughts; he must, if he is to succeed in imparting his mathematical knowledge to others, possess the art of exposition to a degree greater probably than is required in the teaching of any other branch of science. A practical test supplemented by our own reading of the book has convinced us that Mr. Low has this art to an uncommon extent, and that as an interpreter of the symbolism and processes of mathematics he knows how to avoid ambiguity on the one side and verbosity on the other.

The ground which Mr. Low covers in the four hundred odd pages to which his book extends is wide, sufficiently wide, in fact, to justify anyone who masters all the chapters in claiming more than an average knowledge of mathematics. In addition, if he works the numerous examples and exercises conscientiously, he will find that he has not only acquired a familiarity with mathematical processes, but has progressed considerably in his ability to apply them to practical purposes.

Beginning with a chapter on equations, the book leads the reader through partial fractions, indices, and surds to logarithms. Then come chapters on trigonometry, series, plane co-ordinate geometry, conic sections and solid co-ordinate geometry. The eleventh chapter gives a useful discussion of the determination of empirical laws, and is followed by four chapters on the differential calculus and four on the integral calculus. Thereafter, polar co ordinates are considered, to which there succeeds a discussion of curvature and envelopes, complex quantities, Taylor's and Maclaurin's theorems, the calculus of finite differences, harmonic analysis' differentials, and, finally, differential equations.

The book is one which any student with a limited amount of previous mathematical knowledge will find helpful and stimulating. To those whose familiarity with mathematics has become dimmed with the passage of time, it may be thoroughly recommended as a means of refreshing their acquaintance with the subject.

Farm Tractors. By ARCHIE A. STONE. London: Chapman and Hall, Ltd. New York: John Wiley and Sons, Inc. 25s.

THIS book belongs to the Wiley Farm Series, and the author's objective has been to collect and present in a readable form practical information on the construction, operation, and repair of farm tractors. He has, however, confined his attention to the products of America and Canada, and he divides the machines into three classes, namely, the four-wheel standard, the tracklayer, and the general purpose tractor. In order to widen his readers' knowledge of the subject, the author includes a lengthy illustrated description of a typical tractor factory, commencing with the foundry and passing through the many departments, until the final testing shops are reached.

One of the most useful chapters is that devoted to "Loading the Tractor." This contains an instructive table giving a summary of results of tractor tests carried out with much thoroughness by the Department of Agricultural Engineering at the University of Nebraska last year. Other useful information in this connection is included on the average resistance of different kinds of soils and the draught of field machines when engaged on various operations. It is singular that no mention is made by the author of the heavy oil tractor which has made considerable progress in this country during the last few years, and this absence would suggest that British tractor builders are leading in this branch of engineering.

The chapters on carburetters, magnetos, cooling systems, lubrication, and other essential parts of the petrol tractor will be found useful to users of these machines. They contain many well-executed illustrations from photographs and drawings, and although the author gives credit for these to the manufacturers of the tractors, advertising is not unduly obtrusive.

SHORT NOTICES.

Induction Coil Theory and Applications. By E. Taylor Jones. London: Sir Isaac Pitman and Sons, Ltd. Price 12s. 6d. net.—This book contains a less detailed and more descriptive account of the action of induction coils than that given in the author's "Theory of the Induction Coil," published eleven years ago. But all the essential features of the theory are retained in the present volume, and full use has been made of portions of the earlier book where they appeared suitable for the purpose of the present one. Oscillographic records are used largely to illustrate the subject, and the relative merits of coils and transformers as generators of high potentials are discussed. One of the most important uses to which induction coils are put is that of producing ignition on motor car engines, and due attention has been paid to this matter. Again, the induction coil has recently proved to be a very suitable generator of cathode ray beams for the study of electron defraction phenomena, and a description of experiments carried out in this connection is included. At the present time much use is made of the sustained oscillations of coupled circuits, especially those in which the amplitude is kept constant by the action of a valve. A chapter is therefore devoted to triode oscillations in coupled circuits. There is an important difference, the author explains, between maintained oscillations and the transient vibrations which follow a sudden alteration of the circuit conditions. In the latter both component vibrations are usually strongly in evidence together, but in the oscillations maintained by a valve only one of the components is usually present, and it is only in very special circumstances that both oscillations can be maintained simultaneously. This question is discussed in the chapter on triode oscillations in which the conditions for the maintenance of one component or the other, or both together, are explained.

The Electrical Age. By V. H. L. Searle. London: Ernest Benn, Ltd. Price 10s. 6d.—Encouraged by the reception accorded to his book on "Every-day Marvels of Science," published about a year ago, Mr. Searle has produced this new volume on "The Electrical Age." In it, he discusses such matters as What are things made of? Producing a Vacuum; the Spectrum; X-Rays; Electricity in the Home; Refrigeration; and the Measurement of Low Temperatures; Furnaces and the Measurement of High Temperatures; and the Recording of Speech and Music. Written in simple language, the book should present few difficulties to those who have not hitherto studied scientific affairs. Those anxious to familiarise themselves with the principles of certain electrical appliances used in the home and elsewhere will find the book helpful.

BOOKS RECEIVED.

Vibration Prevention in Engineering. By A. L. Kimball. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 15s. 6d. net.

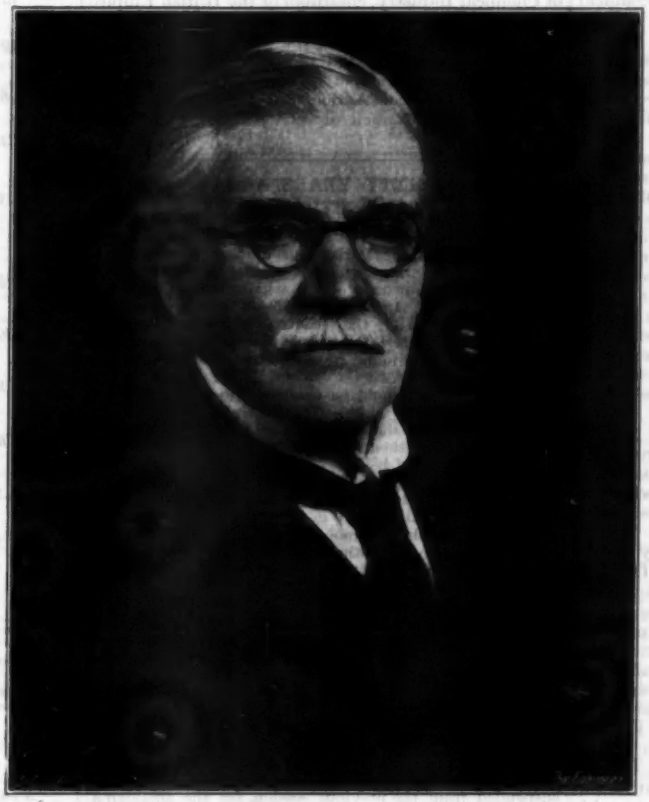
The Wickert Truss. By D. B. Steinman. New York: D. Van Nostrand Co., Inc., 250, Fourth-avenue, N.Y., U.S.A. Price 2·75 dollars net.

Obituary.

SIR DUGALD CLERK.

It is with regret, not only for the passing away of the man, but for the loss of a great engineer, that we have to record the death of Sir Dugald Clerk, last Saturday, at his home at Ewhurst, Surrey, in his seventy-ninth year. In his early years Clerk's interest was caught by the gas engine, and to internal combustion engineering he ever afterwards continued to devote a large part of his attention. He may, in fact, justly be described as one of the pioneers of the modern motor age, and it is for his work on the gas, oil, and petrol engine that his name will chiefly be found in the history of engineering development during the close of the nineteenth and the opening of the twentieth century. As an authority of international repute on the internal combustion engine he was in touch with numerous branches of science and industry, was an honoured member of many learned societies, and was much sought after by Government departments and educational bodies. Through the National Gas Engine Company, Ltd., of which he was a director, he was in close contact with the manufacturing and commercial side of engineering. As a partner in Messrs. Marks and Clerk he occupied a prominent position as a patent agent and consultant. Endowed by Nature with the high qualities necessary for the conduct of successful research, he was distinguished as an investigator and inventor. With practical teaching experience in his younger days, he found much scope, not only for his abilities as a lecturer, but in the administration of the business of educational establishments and foundations. His character and interests were indeed many-sided. It is given to but few men—certainly to but few engineers of modern times—to achieve so much in so many different spheres of activity.

Dugald Clerk was born at Glasgow on March 31st, 1854. He was the eldest son of Donald Clerk, a machinist, and undoubtedly inherited more than the usual share of the engineering instinct which is said to be the birthright of most Scotsmen. In 1868, when only fourteen years old, he left school and entered his father's works, studying mechanical drawing in the evenings at the Mechanics' Institute. In November of the same year he became a pupil under the head draughtsman to Messrs. H. O. Robinson and Co., engineers, Glasgow. He remained in that position for about eighteen months and then decided that he would attend College. For the next five years from 1872 to 1876 he pursued a scientific training at the Andersonian College, Glasgow, and at the Yorkshire College of Science, Leeds, at which institution he taught chemistry as lecturer-assistant to Professor T. E. Thorpe. Returning to Glasgow, he was appointed senior assistant to Dr. E. J. Mills in the Young Chair of Technical Chemistry, in which post he remained for about a year.



SIR DUGALD CLERK

At the beginning of 1876 Clerk was attracted by the internal combustion engine, which at that date was just on the point of emerging from the long period of development which marked its approach to the form in which we now know it. He was convinced of the coming importance of the engine as a factor in the advancement of the world's civilisation, and for the next twelve years he devoted his life entirely to the scientific and practical side of the subject, first at the Crown Ironworks of Thomson, Sterne and Co., engineers, of Glasgow, and later at Messrs. Tangyes' works at Birmingham. During that period he made many inventions and discoveries relating to the explosion of and propagation of flame in combustible mixtures, which were to prove of vital importance all over the world in the development of the gas, petrol, and heavy oil engine.

In 1888 he joined Sir George Croydon Marks—now Lord Marks—in consulting engineering work and developed an extensive practice as an adviser on questions of patents dealing with inventions of every kind. In 1892 he became interested in the subject of ammunition and was appointed a director of Kynochs, Ltd., and in conjunction with the late Mr. Arthur Chamberlain, of Birmingham, designed and constructed ammunition machinery, including machines for making brass cartridge cases for naval quick-firing guns. In 1902 he became a director of the National Gas Engine Company, Ltd., and took an active part subsequently in the conduct of the firm's business and in the design of the internal combustion engines which it produced.

In order to understand Clerk's contributions to the development of the internal combustion engine something must be premised concerning its history up to the time when he began his work upon it. Following numerous proposals and half successful attempts, Lenoir, about 1860, invented the first gas engine for which anything approaching commercial success could be claimed. The Lenoir engine was virtually a high-pressure steam engine, in which a mixture of gas and air took the place of the steam. Two years later Beau de Rochas published his celebrated pamphlet in which he laid down the essential conditions governing the economical operation of gas engines. Among these conditions he clearly enunciated the principle that the pressure of the charge should be the greatest possible at the beginning of expansion. In addition, he outlined the ideal cycle which should be followed in order to realise his prescribed conditions, namely, the now familiar four-stroke cycle, involving in succession suction, compression, ignition and expansion, and expulsion of the products. In 1867 Otto and Langen made a commercial success of a free piston type of engine, in which the practical difficulties encountered in an earlier Italian engine intended to work on the same principle were overcome.

In 1873 the Brayton engine was produced in America. This engine had two cylinders, one acting as a pump and the other as a power cylinder. On the outstroke of the pump piston gas and air were drawn into the pump cylinder and on the return the mixture was compressed into a receiver at from 60 lb. to 80 lb. pressure. The power cylinder took its supply from the receiver. The mixture was ignited as it entered the cylinder, a grating preventing the flame from passing back into the receiver. In other words, the mixture, as such, did not enter the power cylinder. What entered it was a continuous flame. At a given point the supply of flame was cut off, and as the piston moved to the end of its stroke the hot gases were expanded almost down to atmospheric pressure. The engine gave one power impulse per revolution. While more mechanical than the Otto and Langen "free piston" engine, its economy was insufficient to enable it to compete with that design.

The free piston engine suffered by virtue of the noise produced by its rack and other parts, and in 1876 Dr. Otto superseded it with his "silent" engine. This engine adopted the Beau de Rochas cycle in its entirety and showed a much improved efficiency. Very strangely, Otto attributed the enhanced economy of his engine to the slowness of the explosion and the stratification of the gases within the cylinder—ideas previously promulgated by Lenoir—and failed entirely to recognise the importance of the compression of the charge. He considered, in fact, that the compression was an accidental and non-essential feature of his invention.

Such was the state of development of the gas engine when, in 1876, Dugald Clerk's attention was attracted to it by his discovery of an Otto and Langen engine at work in a Glasgow joiner's shop driving a circular saw. The engine was of 3 horse-power and was very cumbrous and noisy. Clerk immediately set about designing an improved engine. This engine was built at his father's works towards the close of 1876. It was of the air pressure vacuum type, in which the explosion compressed air into a reservoir and caused a partial vacuum in the explosion chamber and a vessel connected with it. While he was experimenting with it he became acquainted with Mr. Louis Sterne, of Thomson, Sterne and Co., and entering into an agreement with that firm, he, at the beginning of 1877, transferred his engine to the Crown Ironworks. For the next nine years—that is, until 1885—he remained with the firm and devoted his whole time to inventing, designing, building, and testing gas engines. At the same time he studied the scientific side of the subject and eventually established the fundamental laws of gaseous explosion and the theory of compression.

At the end of 1877 Messrs. Sterne imported from America a Brayton engine of 5 H.P., designed to use petroleum as a fuel. It was handed over to Clerk to be studied and tested. This engine and the rumours which reached him concerning Otto's silent engine turned his attention strongly towards the subject of compression in gas engines. He began by altering the Brayton engine and, obtaining encouraging results, he designed and built in 1878 a true compression engine. This engine employed a pump to compress the gaseous mixture into a reservoir at the full pressure required for compression. During the early part of the working stroke of the engine piston the compressed mixture was admitted to the cylinder and, after the supply was cut off, ignited. The explosion and expansion drove the piston forward, and on the return stroke the products were expelled. The engine developed 3 B.H.P. at about 200 r.p.m., and after testing it for about twelve months Clerk exhibited it at the Royal Agricultural Society's Show at Kilburn, London, in July, 1879. A larger engine of 9 B.H.P. of the same type, but embodying certain improvements, was subsequently produced, but Clerk was still dissatisfied with certain points of detail and did not put the design on the market.

Continuing his experiments, he produced in 1881 an engine employing what soon became known as the Clerk cycle, or, as it is now called, the two-stroke cycle. In it the pump acted only as a displacer, which transferred the mixture to the working cylinder at a pressure of about 4 lb. per square inch. The entering charge drove before it the products of the previous explosion and expelled them through ports overrun by the piston towards the end of its stroke. The charge was compressed during the return stroke and during the next outward stroke was ignited, expanded, and exhausted. This type of engine or modifications of it were made by several manufacturers and considerable numbers were produced during the succeeding nine or ten years. In 1890, however, it fell out of use by reason of the fact that in that year the Otto patents lapsed and nearly all engineers adopted the Otto cycle. Clerk's two-stroke cycle engine was, in fact, before its time. Not until many years later, when the growth in the size of internal combustion engines made it necessary to seek some means of producing a given power with reduced engine bulk, did the two-stroke cycle engine come into its own.

Almost from the very outset of his connection with the gas engine Clerk maintained that Otto's view was erroneous, that compression should be carried as high as the strength of the cylinder and leakage past the piston would permit, and that quick inflammation of the mixture while it was still in the compressed state at the beginning of the working stroke was the ideal at which to aim. He also doubted Otto's contention regarding the value of stratification in the charge. If he did not immediately succeed in disproving the contention, he definitely established the fact that stratification did not exist in the Otto engine and therefore could not be held to account for its improved economy.

Of Clerk's later work on the internal combustion engine it would require many pages to write an account. His first published contribution to the

scientific literature of the subject was made in April, 1882, when he read a paper, "The Theory of the Gas Engine," before the Institution of Civil Engineers. That paper not only was awarded the Watt Medal and the Telford Premium, but attracted to its discussion Dr. Siemens, Dr. John Hopkinson, Sir Frederick Bramwell, Macfarlane Gray, Sir William Armstrong, Sir William Thomson, and other eminent engineers and scientists. In 1886 he read before the Society of Chemical Industry a paper on "The Specific Heats of Gases at High Temperatures," a subject on which subsequently he contributed very extensively to our knowledge concerning the phenomena of combustion. In 1904 he delivered the James Forrest Lecture, taking as his subject "Internal Combustion Motors," and in 1905 he took the same subject for his Cantor Lectures before the Royal Society of Arts. Before the Royal Society in 1906 he presented a paper dealing with specific heat, heat flow, and other phenomena in the internal combustion engine, and two years later, for his work on the subject, he was elected a Fellow of the Society. As President of the Junior Institution of Engineers in 1905 he delivered an address on "The Problem of the Gas Turbine," and as President of the Engineering Section of the British Association in 1908 he chose as his subject a general discussion of the principles of thermodynamics. From 1908 to 1912 he contributed several important communications to the Gaseous Explosions Committee of the British Association, among the subjects dealt with being dissociation in steam and carbonic acid and the effect of turbulence on heat flow. In 1915 he delivered the Thomas Hawksley lecture before the Institution of Mechanical Engineers, taking as his subject "The World's Supplies of Fuel and Motive Power," and in 1920 he was selected by the Institution of Civil Engineers to give a second James Forrest lecture, his subject on this occasion being "Coal Conservation in the United Kingdom." In that year also; as President of the Institution of Gas Engineers, he delivered an address on "The Future of the Gas Industry." One of his latest contributions dealt with "Standards of Thermal Efficiency for Internal Combustion Motors." It was delivered in 1928 before the Institution of Civil Engineers. During the forty-six years which had elapsed since, as a young man of twenty-eight, he had first addressed that body, the internal combustion engine had reached a stage of development which possibly not even he had foreseen and had been applied on land, at sea, and in the air. He could look back with satisfaction on his own share in the work of its development, for it was undoubtedly true that in almost every stage of that development he had borne an active part.

We have enumerated only a selection of Clerk's more important contributions to the literature of the internal combustion engine, but they are sufficient to show some of the aspects of the subject in which he was interested and to indicate some of the societies and bodies with which he was connected. During the war his knowledge and skill were actively placed at the disposal of the country. He served as Director of Engineering Research to the Admiralty from 1916 to 1918 and was a member of the Panel of the Board of Invention and Research. He was also a member of the Advisory Committee for Aeronautics and Chairman of the Air Board's Internal Combustion Engine Sub-Committee. In addition, he served on the Ministry of Munitions Inventions Committee and on the Trench Warfare Advisory Panel. For his numerous and valuable services to the nation he was created a Knight of the Order of the British Empire in 1917. This year he was elected President of the Institution of Civil Engineers, but his failing health prevented him from taking office.

WILLIAM SCOTT HERRIOT.

SUGAR engineers throughout the world will learn with the greatest regret of the sudden death of Mr. William Scott Herriot, director of The Mirrlees Watson Company, Ltd., Glasgow, which took place early on Tuesday morning last, following a heart attack. Mr. William Scott Herriot was born and received his earlier engineering training in Liverpool, completing his courses in Glasgow engineering shops and at the Glasgow University. He became chief draughtsman to one of the oldest marine engineering firms on the Clyde, and resigned his duties there on the invitation of the proprietors of a group of sugar estates in Demerara to take up the position of engineer to their factories. He remained there for twelve years, during a highly important phase in sugar manufacturing development, being engaged upon the arduous and responsible duty of designing new factories according to modern practice, and, perhaps, the even more difficult task of replacing the old open evaporation plants by modern machinery. Mr. Scott Herriot did not confine his attention only to the mechanical aspect of sugar production, important as that is, but became absorbed in the whole question of sugar and its manufacture, reinforcing the invaluable experience he had gained in supervising the transition from old to modern methods in Demerara by journeys in search of technical information throughout the cane-growing districts of the West Indies, as well as to Cuba, Mexico, United States of America, Spain, the Canaries, Philippines, Java, India, Malaya, Mauritius, Kenya, Portuguese Africa, and South Africa. Having completed the work of establishing new methods in the factories under his charge, he returned to England in 1895 as works manager for a well-known firm of engineers in Derby. In 1900 he went as manager to The Mirrlees Watson Company, Ltd., of Glasgow.

The exceptional experience which Mr. Scott Herriot was enabled to acquire resulted in a conviction that, in order to carry on adequately modern practice in sugar factories, it was essential that a school should be established to give a thorough training to young men before going abroad, and it was very largely owing to his efforts that the Sugar School of the Royal Technical College, Glasgow, was established. A very large number of sugar engineers all over the world owe their first step forward in the sugar industry to Mr. Scott Herriot's keen interest and ready personal assistance.

He was blessed to a very remarkable degree with the gift of memory of persons. It is said that he could give the history of any engineer in the sugar industry during the many years he had been engaged in it, and at a moment's notice could say what man was suited by experience and abilities for any post. Thus, as far as that industry is concerned, he was a veritable "employment bureau" in himself alone. Fortunately, The Mirrlees Watson Company insisted some years ago on his acceptance of an assistant in the person of Mr. D. M. Semple, who will now carry on his work.

Mr. Scott Herriot was an associate member of the Institution of Civil Engineers, a member of the Institution of Mechanical Engineers, and of the Society of Chemical Industry, chairman of the British Empire Sugar Machinery Manufacturers' Association, a member of the Councils of the British Empire Producers' Organisation, and of the Sugar Federation of the British Empire, a Governor of the Imperial College of Tropical Agriculture (Trinidad), and a member of the Council of the Glasgow West India Committee.

SIXTY YEARS AGO.

THIS, it appears, is the diamond jubilee year of the blue print. From our issue of November 22nd, 1872, we learn that Monsieur Marion, of Paris, had devised a method of photographic printing, which consisted of impregnating paper with ferro-prussiate, by which it was rendered sensitive to light. A drawing, made on tracing paper, was laid as a negative on the sensitised paper and exposed to light. Thereafter, the paper was washed in water, when the copy was found produced upon it in white lines upon a blue ground. By the use of a tannin solution, it was added, the ground could be changed from blue to black, the work remaining white. The general adoption of the blue print marked the end of the old-time draughtsman and his highly finished drawings, many of which almost reached the point of being works of art. It was therefore almost superfluous, had we but known it, for us to publish in the same issue detailed instructions intended to enable beginners to emulate him in one of his minor accomplishments, namely, the mounting of drawings or tracings on brown holland or other linen or cotton base. The instructions were elaborate, but the necessity for mounting drawings and tracings in the manner described also disappeared very largely with the introduction of blue prints. . . . In a short note dealing with private Bills to be presented in the approaching session of Parliament, we read that the Caledonian Railway had given notice of an application for powers to construct a central station at Gordon-street, Glasgow, together with a new bridge across the Clyde and lines to connect the proposed station with the railways on the south side of the river. We had reason to believe, we added, that steps would be taken to reintroduce a Bill for the great Forth Bridge project. Notice had also been given of a renewal of the proposal, suspended from the previous session, for the amalgamation of the Midland and the Glasgow and South-Western lines, and it was anticipated that the proposal for the amalgamation of the London and North-Western and the Lancashire and Yorkshire railways would also be reintroduced. The four companies which had the railway territory of the south-western counties in their hands would also, we remarked, probably again seek authority to enter into a perpetual arrangement, which, so far as the public was concerned, would amount to amalgamation. The whole question of railway amalgamation had, we reminded our readers, been referred to a Joint Committee of the Lords and Commons. The report of that Committee would, we suggested, probably influence the decision arrived at when these various amalgamation proposals were placed before Parliament.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

MANHOLE OPENINGS.

No. 470—1932. This specification covers the size and position of manhole openings for chemical plant—fixed and mobile—and is not applicable for pressures over 175 lb. per square inch. The requirements have been grouped under three headings: (1) Process Vessels; (2) Mobile Tanks (except those for Liquefied Gases); and (3) Storage Tanks (except those for Liquefied Gases). With regard to Nos. 1 and 3 it is specified that "wherever it is reasonably practicable" such vessels shall be provided with at least two manholes, whilst in the case of No. 2 each tank shall have at least one manhole, and if the tank is divided into compartments one manhole in each. In all tanks manholes shall be 18in. diameter or 18in. square, or if oval 18in. by 16in. by preference and not less than 18in. by 14in.

Large Mercury Rectifiers and their Design.*

THE advances that have been made in the designing of large mercury rectifiers have been largely the result of laboratory research. This is due to the fact that, when investigating problems connected with mercury rectifiers, one has to deal with atomic phenomena which are not yet fully elucidated. The phenomenon of back-firing, in particular, is one that comes under this heading. In other words, it is necessary, before an answer can be given to the question as to what are the conditions under which back-firing occurs, to be able to determine the actual path followed by each of the atomic particles taking part in the working process of the mercury rectifier. This is a task that cannot at present be accomplished. It is, however, possible to influence the path of the whole beam of electrons and ions, in such a way as to ensure the reliable operation of the rectifier, so that equipments can now be built which fully satisfy the severe conditions imposed.

The mercury rectifier consists essentially of a vacuum container with an insulated dish-shaped receptacle with a mercury cathode at the lower part, and with several insulated electrodes forming the anodes fitted to the cover. The electrons are liberated at the surface of the cathode and travel to the particular anode, which is positive in

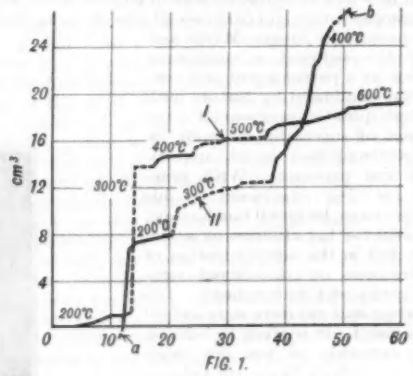


FIG. 1.

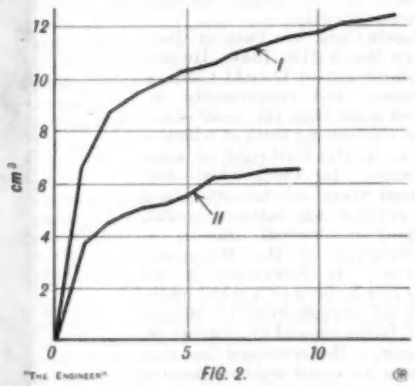


FIG. 2.

FIG. 1—*Quantities of Gas Emitted, in cm³, by a Piece of Iron and by Graphite (Ordinates) at Increasing Temperatures, Number of Heating Operations (Abscissæ). Each Heating Operation Lasted Two Hours.*

I. *Anode Iron.*
II. *Graphite.*
a, b. Steam and Gas.

FIG. 2—*Quantities of Gas Emitted by a Piece of Anode Iron Number of Heating Operations (Abscissæ). Each Heating Operation Lasted Two Hours.*

I. *First De-gassing Operation.*
II. *De-gassed Block after having been Exposed to Air at Atmospheric Pressure for Four Months.*

relation to the cathode. On their way to the anode, they produce by impact with neutral mercury atoms, positive ions which move to the cathode. The electrons produced at the same time travel to the anode, like those from the cathode. As the electrons are much lighter than the mercury ions, and thus have a much higher velocity, practically the whole current is carried by the electrons; about 10^{19} electrons travel per ampère per second to the anode.

As soon as an anode is negative to the cathode, it ceases to take electrons which then go to another anode, which, is positive with respect to the cathode. The negative anode which no longer takes any electrons has, on the other hand, the tendency to take positive charges from the arc. As these positive charges, consisting of mercury ions, are some 300,000 times heavier than the electrons, the number reaching the anode is small and the velocity low. It may, however, happen that one of these mercury ions has a sufficient speed to dislodge electrons from the solid anode. The "valve action" then ceases and back-firing takes place. This is more likely to occur when the anode has a high negative potential, *i.e.*, when the rectifier works with a high pressure, and when there are many such ions in the neighbourhood of the anode in question at the time the current is interrupted. The conditions are also more favourable for back-firing, when the anode has at its surface certain oxide particles, which liberate very light electrons. Another important factor is the amount of gas given out by the anode, when on load. If too much gas is emitted, and the anode is negative, "shock" ionisation takes place in the upper layer of the gas, and this also

* From a paper read by Dr. Wellauer, of Oerlikon, before the Swiss Association of Electrical Engineers, and published in the "Schweizerischer Elektrotechnischer Verein," Vol. 23, No. 4.

leads to back-firing. This emission of gas occurs when the anode is at a high temperature. Before the mercury rectifier is put into service, the anode must, therefore, be carefully de-gassed. This de-gassing of the anode, and, in a general way, of all parts of the rectifier subjected to heating, is the most important problem to be dealt with when building mercury rectifiers. It was only when this fact was realised and the necessary measures taken that it became possible to build reliable mercury rectifiers.

This de-gassing of anodes is no easy task. Gases leave a solid body only in vacuum, and when the material is subjected to a high temperature. The problem for the designer is, therefore, to make anodes which can be heated to white heat, together with their insulating bushing, without the insulating being damaged. Should an insulator crack, porcelain dust escapes from the crack, and this leads, in most cases, to back-firing, if the crack is accessible to the arc.

In Fig. 1 curves are plotted giving the quantities of gas emitted by a piece of iron and by graphite, as a function of the number of heating operations, the temperature being raised in steps. It will be seen from these curves how slowly the gases leave the solid material, as each heating operation lasted two hours. In the case of every temperature, the emission of gas ceased after a given time, but started again when the temperature was raised. The quantity of gas emitted decreased with increasing temperature, but, in the case of iron, the emission had not come to an end at 600 deg. Cent. The measurements were made with special apparatus designed for the purpose.

Tests were also carried out with a view to ascertaining how long a piece of de-gassed anode iron remains free from gases after it has been exposed to air at atmospheric pressure. The results are shown in Fig. 2, where it will be seen that after a period of four months the iron block had absorbed a considerable quantity of gas. These tests and the actual results obtained in practice tend to show, however, that the opening of a mercury rectifier for a short time only affects the anode to a small extent, so that the rectifier can be put into service again after a short de-gassing operation, but the case is different when the rectifier is being put into operation for the first time.

Cause of Heating.—As stated above, the object of de-gassing the anodes is to prevent, as far as possible, the emission of gases, even at the highest temperatures when the rectifier is working under heavy loads. It may

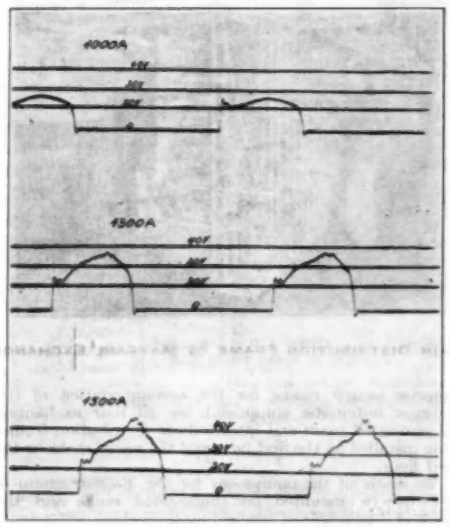


FIG. 3—*Pressure Drop in a Metallic Rectifier at Increasing Temperatures.*

now be of interest to investigate the causes of the heating of the anodes. From a purely electrical point of view, the heating is due to the pressure drop at the anode, or, to use a simpler expression, to the "anode drop." The energy W supplied to the anode is thus the anode drop V multiplied by the anode current A.

From a physical point of view, the anode drop may be regarded as representing the additional pressure required at the anode for drawing the electrons from the arc. The electrons receive a certain amount of kinetic energy corresponding to the anode drop, and this energy is released on the anode by the electrons in the form of heat. The heating of the anode thus depends, in the first place, upon the anode drop and the current density at the anode. The anode drop is not merely proportional to the current density at the anode, but it has a minimum value of 5 to 7 volts for a normal current density. It only increases when the current density, after reaching the value corresponding to this minimum anode drop, at all points of the anode surface, assumes a higher value as a result of the current increasing. This increase in anode drop is, of course, accompanied by a decrease in efficiency.

The oscillograms—Fig. 3—show the anode-cathode pressure drop for three load conditions. The top oscillogram corresponds to the limit of the normal anode drop. In this case the pressure drop has a nearly constant value of 22 volts during the whole burning period. The middle oscillogram shows the pressure drop for a 30 per cent. higher load. At the beginning of the burning period the drop is again about 22 volts, but it increases up to the middle of the burning period, and then decreases rapidly. This phenomenon is still more pronounced in the case of the third oscillogram, which is for a load 50 per cent. higher. Tests have shown that the increase in anode-cathode pressure drop is entirely due to the increase in anode drop, and the time taken by this drop to reach its maximum can be regarded as the charging time of the anode.

Three courses can be adopted with a view to keeping the anode drop, and consequently the anode loading, within the most economical limits. First of all, the number of anodes can be increased; secondly, the anodes can be given larger dimensions (that is to say a larger surface); thirdly, the burning period can be lengthened. It is essential to decide which of these means leads to the best results from an economical point of view. The size of anode cannot be increased beyond certain limits, as otherwise the distribution of current over the surface of the anode ceases to be uniform, and excessive heating may occur owing to the concentration of current at certain points. In view of this, it is as a rule necessary to increase the number of anodes in the case of heavy currents. At the present time, six-anode rectifiers are built for currents up to about 1500 ampères, twelve-anode rectifiers for currents up to 5000 ampères, eighteen-anode rectifiers for currents up to 10,000 ampères, and twenty-four-anode rectifiers for currents above the latter figure.

The heat of the anode is led away partly by conduction and partly by radiation. Tests have shown that, in the case of small loads, and consequently low temperatures, the portion of heat dissipated by conduction is preponderant, while at a normal working temprature of 600 deg. to 700 deg. Cent. the heat radiated is more than double that dissipated by conduction. It was originally believed that the anode should be cooled in order to avoid excessive temperatures. The view at present, however, is that the best results are obtained by working with a temperature of 500 deg. to 700 deg. Cent. at full load. The reason why a high temperature has a favourable effect is that it ensures a lower density of mercury vapour in the imme-

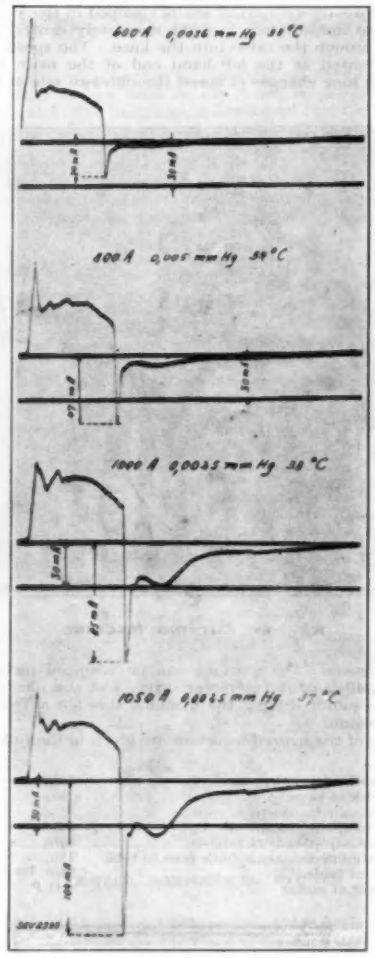


FIG. 4—*"Return Current" of a Rectifier for Different Loads.*

diate neighbourhood of the anode, and consequently reduces the likelihood of ionisation.

The high anode temperature, and consequently low density of mercury vapour, also assists the de-ionisation of the anode space, which must take place immediately the current has stopped flowing. In order to accelerate the de-ionisation it has been customary to provide grids as concentration centres for the electrons and ions, which are known to collect on solid surfaces.

The only means available for gauging the state of the ionisation of the anode space is to measure the return current; that is to say, the current which the non-working negative anode supplies or takes under these conditions. A number of such measurements were made on a metallic rectifier by means of an oscillograph, and the oscillograms obtained are reproduced in Fig. 4. The return current is below the zero line and represents either an electron current supplied or an ion current taken, or both kinds of charges, the positive ion current being predominant. As can be seen, after the extinguishing of the anode current the return current rises to a sharp peak, but is rapidly damped immediately afterwards. In the case of heavy loads, after the first drop there is a second peak of smaller amplitude.

It can be assumed that the first peak is due to the diffusion of the "remanent charges" in the neighbourhood of the anode; that is, charges which have not disappeared instantaneously after the rapid extinction of the anode current. From a back-firing point of view, this return current is only to be regarded as dangerous when the peak has a high value. The second part of the return current can be taken as the charging current due to the passage of the mercury vapours, and this part of the return current must be regarded as dangerous from the point of view of back-firing.

As mentioned above, mercury rectifiers are provided with grids which are fitted at a short distance from the anode in the anode insulating sheath, and are connected to the container of the rectifier through resistances. The effect of these grids is not only to de-ionise the anode space, but to retain the positive ions of the space where the arc is burning and to prevent them from going to the negative anode and ionising the space in front of the anodes, thus causing conditions such as may give rise to back-firing. This action of the grid is due to the fact that the container of the rectifier has practically the potential of the cathode, as it is continually in contact with the ionised mercury vapours. As the grid is electrically connected to the container, the potential of the cathode is brought in front of the anodes; that is to say, the negative field of the non-burning anodes is electrically screened. In view of this arrangement, nearly the whole negative anode pressure is located in the small anode-grid section, while the long grid-cathode section has only a pressure

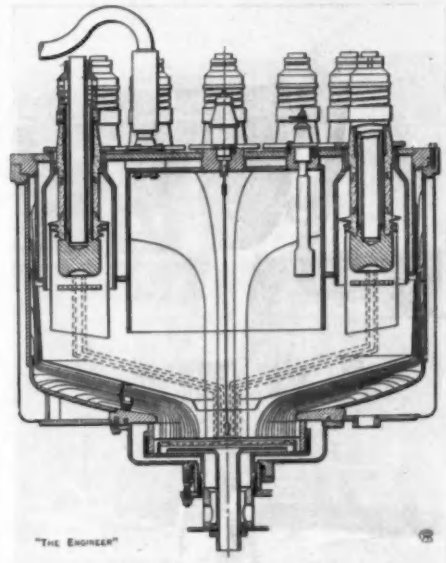


FIG. 5—*Arrangement for Guiding Mercury Vapours in Oerlikon Mercury Rectifier.*

of 15 to 20 volts. Tests have shown that this uneven distribution of the potential drop is favourable for the operation of rectifiers and renders back-firing more difficult.

It may be of interest to examine what measures are taken to prevent non-ionised mercury vapours from penetrating into the anode space. For this purpose it is necessary to examine what takes place at the cathode. The cathode mercury is heated in a similar way to the anode by the bombardment of electrons, and to a greater degree than actually necessary for producing the mercury vapours required for carrying the current. The non-ionised vapours rise from the cathode surface with a high velocity and condense on the cold parts of the container.

It is important to bear in mind that the evaporation of mercury takes place not only at the point of contact of the arc but over the whole surface of mercury, the degree of evaporation being dependent upon the temperature of the cathode. It is therefore necessary, in order to reduce the quantity of mercury vapours, to cool the cathode.

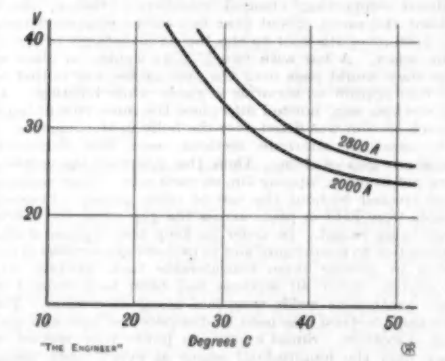


FIG. 6—*Anode-Cathode Pressure Drop as a Function of the Temperature of Anode Plates, at Two Different Loads.*

On the other hand, means have to be provided for guiding the mercury vapours produced, and for preventing them from condensing in the anode spaces.

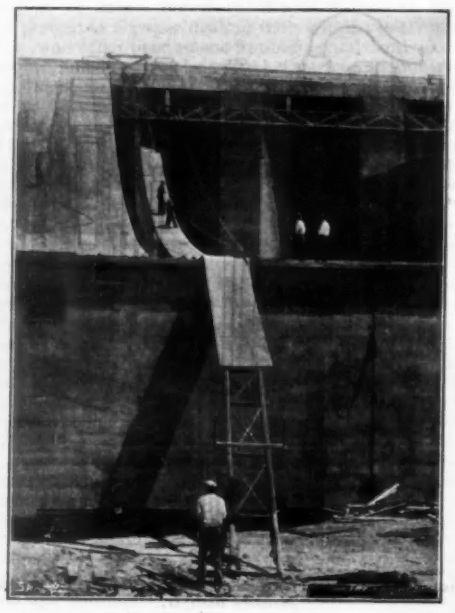
Fig. 5 shows the arrangement adopted on the Oerlikon Company's rectifiers. The mercury is given a large evaporating surface and a funnel-shaped arc guide with as small an opening as possible is provided over the cathode, so that most of the vapours are led laterally to the walls of the container. On the other hand, the anode sleeves are extended fairly low down, and in view of this only a relatively small portion of the mercury vapour penetrates into the central chamber.

Finally, let us consider the anode-cathode pressure drop. The pressure drop in the arc depends, in the first place, upon the distance between anode and cathode. Under normal conditions the drop is about 5 to 8 volts. The pressure drop varies also with the pressure of the mercury vapours. The latter pressure depends, to a certain extent, upon the temperature of the surfaces upon which the mercury vapours condense. It is thus possible by cooling these surfaces to a greater or lesser degree, to alter the pressure of vapours, and consequently the pressure drop. Fig. 6 shows how the pressure drop of a mercury rectifier varies with the temperature of the anode plates at two different loads.

A Self-Supporting Welded Steel Roof.

We are indebted to Buck and Hickman, Ltd., of Whitechapel-road, E.1, who represent in this country the interests of the Lincoln Welding Company, for the following interesting particulars of a self-supporting welded steel roof erected on four large grain elevators built by the New York Port Authorities for the Port of Albany. The welding and erection of the roofs was carried out by the J. K. Welding Company, of New York City.

As will be seen from the accompanying engraving, the roofs are of a novel construction. Each of them measures 288ft. wide, with a total span of 140ft., and forms a catenary curve supported only at the top and bottom. Seventy-six sections of 12-gauge mild steel sheets, 140ft.



ERECTION OF SELF-SUPPORTING WELDED ROOF

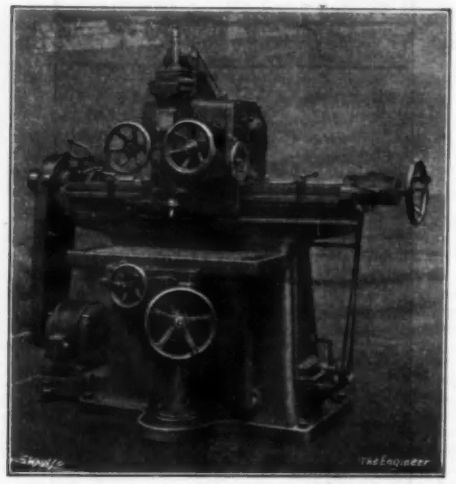
in length and 50in. wide, compose each roof. The lower part starts on a ramp, approximately 22ft. above the ground level, and extends upward at an angle between 30 deg. and 40 deg. Both the top and bottom ramps were constructed at an angle to conform with the slope of the roof at those points. The steel was ordered in lengths of 5ft., 10ft., and 31ft. 3in., and each section was assembled and welded on the ground, five sheets forming a section. At the ends of each section were two rows of ¾in. bolt holes. The outside rows were used for erecting purposes and the inside rows for anchoring to the upper and lower supports. A yoke of ½in. steel was bolted to one end of the steel section about to be erected. To this was attached a steel cable running through a sheave at the top of the upper roof platform and thence downwards to a hoisting engine on the ground level. As the section was hoisted upwards it was first guided to the top of the wall by inclined supporting channel members; thence, as it crossed the ramp, it slid over two cables stretched from the bottom of the roof to the top at a distance of about 36in. apart. A bar with two U-bolts welded in place so that they would pass over the two cables was bolted to the roof section to serve as a guide while hoisting. As the sections were hoisted into place the inner row of holes in each section was fitted over the bolts in the concrete.

In erecting, alternate sections were first anchored, leaving a gap of 46in. Then the intermediate sections were put in place, lapping 2in. on each side. These sections were erected without the use of cable guides. Instead, boards were held in place across the gap while the sheets were being raised. In order to keep the expansion and contraction to a minimum and to prevent unevenness in the plates in joining them considerable tack welding was employed. After all sections had been tack welded in place continuous welds were laid along each seam. The step-back method was used to dissipate the heat and prevent distortion. Small expansion joints were welded in place over the longitudinal seams at every tenth seam, giving the roof free expansion and a floating characteristic. These joints were of 14-gauge steel running one-half the length of the seam. They were staggered on the upper side and the lower side of the roof. On completion the roofs were given two coats of red lead and one coat of aluminium paint, thus protecting the steel from the weather.

More than 400 tons of steel were used in the construction of the roofs, which were built under the supervision of the New York State authorities.

Vertical Slot Drilling and Keyway Cutting Machine.

The keyway-cutting machine illustrated is made by George Richards and Co., Ltd., of Broadheath, near Manchester. In operation no previously drilled hole is required, as the cutter first sinks to depth and the horizontal feed is then automatically brought into play. The groove or keyway may be formed to any desired length and depth at one cut. The spindle is carried in the spindle frame, which slides along the main frame of the machine, and has an ample front bearing of the double cone type, which has been found by experience to be very suitable for the work. The spindle nose has an internal taper to receive a spring collet, which is closed by a nut at the top of the spindle. One size of collet only is used, smaller size shanks being accommodated by split bushings. The vertical feed sleeve to the spindle is of generous proportions to absorb the multitude of small shocks received by the cutter, and as the fit of the spindle in its sleeve is of the utmost importance, effective provision is made for adjustment when required. The feeds are arbitrarily arranged with the down feed considerably finer than the longitudinal feed. The down feed is automatically tripped at an exact depth by bringing the cutter to touch the work, and then setting the feed disc at the right-hand side of the spindle frame to the depth required. A second fixed dial is provided to enable the operator to see at a glance the position of the spindle relative to its minimum and maximum projection. The longitudinal feed is set by moving a clamp carrying a finely divided rule along the slide in the main frame and clamping when the required traverse is opposite the index mark attached to the spindle frame. To start cutting, a lever on the front of the spindle frame is put in "vertical" position to engage the down feed, and when the correct depth has been reached the lever automatically falls to "horizontal." The vertical feed then stops and the horizontal feed immediately begins. On reaching the required length of slot the lever falls to "feeds disengaged," when the horizontal feed is also tripped. Ten rates of feed are provided, and a fine hand feed is available vertically, and both fine and rapid hand feed longitudinally. The table is adjustable for height, and a small cross adjustment is provided for irregular work, or work in special jigs. Ordinary cylindrical shafts clamped in the V of the table are immediately brought accurately central by a dowel through the table into the knee. The speed gearbox mounted at the left-hand end of the main frame provides nine changes of speed through two sets of triple



KEYWAY CUTTING MACHINE

sliding gears. The machine can be arranged for either single pulley or direct motor drive, and the illustration shows a motor driving the machine through a Tex rope transmission.

Some of the main dimensions are given in the following table:—

Length of keyway, maximum	30in.
Width of keyway, maximum	2in.
Vertical adjustment of spindle	5½in.
Vertical adjustment of table	14in.
Cross adjustment of table	5½in.
Maximum distance spindle nose to table	18in.
Size of table	36in. by 12in.
Power of motor	4 H.P.

Binocular Magnifying Spectacles.

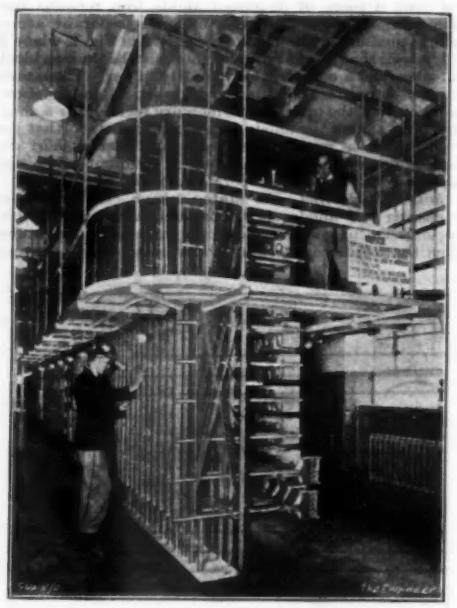
Everyone who does fine manipulative work is familiar with the watchmaker's eye-glass and knows its defects as well as its merits. W. Watson and Sons, Ltd., High Holborn, London, have now sent us for inspection a pair of magnifying spectacles—called the "Speera"—which remove the defect of monocular vision and have lenses far superior to those usually fitted in watchmakers' eye-glasses. The eye pieces of these spectacles are semi-circular, and on a bar on the straight, upper, side there is mounted a little crosshead which carries a powerful cylindrical lens with the inner face ground at a steepish angle. The crosshead, which can be clamped with a screw, permits the lenses to be moved along the bar to suit the separation of the eyes of the user. By this means the spectacles can be so adjusted that a single clear image of the object is obtained, which, of course, retains the stereoscopic effect. The lenses themselves are achromatic and give a sharp flat field. A well-known model maker, who has made use of these magnifying spectacles, tells us that he has found them very convenient for fine work.

The Mayfair Automatic Telephone Exchange.

The new Strowger automatic telephone exchange, "Mayfair," formally opened for public service by the Postmaster-General on Tuesday, November 8th, as reported in our Journal page last week, accommodates for the present the combined Strowger automatic equipment of no fewer than four exchanges, Mayfair, Regent, Grosvenor, and Langham. But this combination of automatic exchanges under one roof is only a temporary measure and marks the first stage of the conversion programme from manual to automatic working in the district. The old Regent exchange was manually operated and occupied a separate building. A new Strowger automatic exchange, to be known as Langham, will take the place of the superseded manual equipment, and when this change is effected the Strowger equipment at present allocated to Langham in the Farm-street, Mayfair, building will be merged into that destined to serve Grosvenor subscribers. The ultimate capacity of the threefold exchange known as Mayfair will be three 10,000-line Strowger automatic exchanges, Mayfair, Regent and Grosvenor. Subdivision of the Strowger equipment in the Farm-street building into four distinct exchanges applies only to the apparatus directly associated with subscribers' lines and the numerical and first-code selectors. The remainder of the apparatus, including the Director's auto-manual equipment and power plant, is common to all three exchanges, a grouping principle which makes for greater efficiency and economy of floor space.

The new Post Office building in Farm-street consists of five floors and a basement, which accommodates the four main 25-cell batteries for operating the equipment and for supplying current to subscribers' telephones. On the ground floor there are three G.E.C. charging motor generators, ringing machines, and a switchboard for controlling this plant. Each of the four batteries has a capacity of 9890 ampère hours, but it may be increased to nearly 12,500 ampère hours by adding positive and negative plates.

The first, second, and third floors of the new building



MAIN DISTRIBUTION FRAME OF MAYFAIR EXCHANGE

comprise switch rooms for the accommodation of the Strowger automatic equipment for all four exchanges, the associated main and intermediate distribution frames being installed on the first floor and the meter racks on the third floor.

The whole of the equipment for the Mayfair group of exchanges is mounted on single-sided racks and the "jack-in" principle of connecting individual components and switches facilitates permanent wiring. Some idea of the dimensions of this Strowger Director exchange can be gauged from the fact that over 700 of these single-sided racks are required to support the equipment. Another interesting feature of the exchange is that a system of flood-lighting has been introduced. To facilitate interworking between existing manual and the newly converted automatic subscribers, considerable auto-manual switchboard accommodation is still necessary and will be required throughout the transition period. Like the previous Strowger automatic exchanges in the London area, the system at Mayfair and at its associated exchanges is the seven-digit system, the first three digits being dialled as initial letters of the name of the exchange and are followed by the four numerical digits representing the subscriber's number.

Owing to their size and the varied nature of their business most of the large London shops and stores that meet the needs of the Mayfair residents require more than one exchange line. Some of them, in fact, have more than 100 separate and distinct exchange connections. But notwithstanding this multiplicity of lines common to an individual subscriber, a single directory listing ensures connection with one or the other of the disengaged lines of the particular group whenever the listed number is dialled. Registration of dialled calls is automatic and is only consummated by the removal of the called subscriber's receiver in the act of replying, so that ineffective calls are not charged to the calling subscriber. The equipment was manufactured and installed by the Automatic Electric Company, of Strowger Works, Liverpool. The accompanying illustration shows the Mayfair main distribution frame.

A New Material for Tracings.

A new material for making permanent tracings has been produced by Kodak, Ltd., from cellulose acetate. It is called "Kodatrace," and resembles an exceptionally transparent tracing linen. Any writing or printing appliance can be used on it freely, and erasure is easy and leaves no marks. Owing to its great transparency

blue prints can be taken, we are informed, four times as quickly as they can with most tracing materials. It is also non-inflamable and imperishable, and being waterproof and washable, the surface is left unmarked if any liquid is accidentally spilled on it. The material cannot stretch, and therefore will remain true to scale. Actually the distortion due to atmospheric humidity and temperature changes is less than one-tenth of 1 per cent. It lies flat and rolls easily. Standard thicknesses of Kodatrace, in rolls 22 yards long and 30in. wide, are being supplied.

Luminous Discharge Tube Lighting.

A PAPER read by Mr. Clifford C. Patterson before the Illuminating Engineering Society on Tuesday, November 8th, deals with the new method of lighting by means of hot cathode tubes. In these tubes, it is explained, the electrodes consist of alkaline earth oxides, which can be heated electrically like small filaments. Alternatively, they may be formed of small oxide-coated metal cylinders, which can be heated by a tungsten spiral inside, much in the same way as the cathodes in indirectly heated cathode valves. By the use of these electrodes the sharp drop in voltage, known as the cathode fall, near the negative electrode is greatly reduced as compared with that in cold cathode tubes and is only about 25 to 30 volts. Much larger currents can therefore be passed without appreciable spluttering taking place; in fact, the current can be increased some 30 or even 100 times as compared with the current permissible with ordinary cold cathodes. The current is now only limited by the heat developed by the discharge, which, if excessive, would soften the glass walls. As a result of the high current the voltage drop (which decreases as the current increases) per foot of positive column is much less than in the case of the cold cathode tubes, and, as stated, the cathode fall is also greatly reduced. The discharge can therefore be maintained with the ordinary supply voltages and no step-up transformer is needed. A choke for the purpose of limiting the current is, however, essential, and a small heating transformer must be provided for the electrodes. It is generally necessary to supply a momentary high voltage to start the discharge, and this can most easily be done by means of a small high-frequency Tesla coil. Examples of gases and vapours that can be used in the tubes are :—

G.E.C. LIGHTING TUBE

Gases	Neon	Red.
	Helium	Ivory white, but yellow in special glass.
	Nitrogen	Buff.
	Carbon dioxide	Daylight white.
	Argon, Krypton, Xenon	Not used alone, but only in conjunction with other gases or vapours.
Vapours	Mercury	Blue to white according to pressure. Green in special glass.
	Sodium	Yellow.
	Cadmium	Greenish blue.
	Thallium	Green.
	Magnesium	Grass green.

A white light can be obtained from a neon tube in which a little mercury vapour is present, provided that just the correct quantity is maintained. The reason why any desired hue of light cannot be obtained by mixing in one tube any of these gases in the right proportions is that in general the gas requiring the lowest voltage to stimulate it will mask those which require higher voltages to stimulate them. Thus the characteristic colour of the gas requiring the lowest voltage will dominate the hue of radiation. Taking a tube containing a gas together with such a metal as mercury, which will evaporate as the tube gets hot, it is found that at low temperatures the gas spectrum shows and at high temperatures that of the mercury, but at some intermediate temperature both the gas and vapour of the mercury are excited. The practical difficulty is to maintain the temperature conditions in such a state of equilibrium that the radiation of both elements remains steady in the desired amounts.

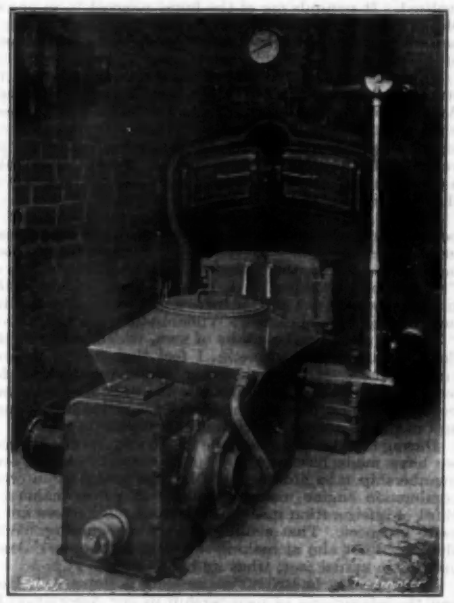
The development of hot cathode tubes has proceeded rapidly during the last year or so, and many types are now approaching the commercial stage. By placing neon and mercury tubes in parabolic reflectors effective units are obtained for the colour flood-lighting of buildings, &c. The efficiency of these units is greatly in excess of the ordinary incandescent lamps combined with colour filters, which at present have to be used for the purpose. By combining a neon and a special fluorescent glass mercury tube a unit is obtained which emits a very pleasant light giving good colour rendering of objects. In this unit the tubes are enclosed behind opal glass sheets which mix and diffuse the light. Another development is the combination of hot cathode tubes with incandescent lamps. In this case neon tubes tint the light and give it a rosy hue. Blue mercury tubes give a daylight effect and, if required, also supply ultra-violet light. The advantage of this combination is that the incandescent lamps not only give useful light, but as they are in series with the discharge tubes they take the place of choke coils.

An interesting new type of tube developed in the G.E.C. Wembley laboratories and now emerging from the experimental stage is made at the moment in 400-watt units. As shown in the accompanying illustration, it consists of a vertical glass cylinder in which the discharge takes the form of an extremely brilliant narrow cord of light about 6in. high. The efficiency of a 400-watt lamp of this type is at present about 40 lumens per watt, as compared with 15 lumens per watt for a corresponding tungsten lamp, but higher values than this have been obtained in experimental tubes. The light from the lamp is deficient in red, but if combined, for instance, with a neon tube much better colour rendering is obtained. It would seem that when fully developed this type of lamp should be particularly suitable for lighting streets and important thoroughfares. The street outside the G.E.C. laboratories is at present entirely illuminated by these lamps, in which, however, the colour is not yet corrected.

There is also a sodium lamp, which emits practically only a pure yellow light. This type was first developed by Pirani, of the Osram Company, Berlin, where researches showed how a glass could be made to withstand the attack of hot sodium vapour throughout hundreds of hours. A similar lamp of modified construction has also recently been developed by the Philips Company in Holland. There is a section of a road lighted with these lamps in Holland and another in Zurich. Early examples of sodium lamps were shown two years ago at the Institution of Electrical Engineers, and further types have recently been under development. A type developed by Pirani and recently constructed at Wembley yields 70 lumens per watt. The lamp lends itself to small ratings—80 to 150 watts—but in view of the extreme colour distortion produced, is not at present very suitable for general or even ordinary street lighting. It is, however, being tried on stretches of arterial and country roads where lack of good colour discrimination is of little importance.

The "Robot" Fireman.

A MECHANICAL stoker for use with central heating and hot water boilers, such as are found in private houses, hotels, and office buildings, is illustrated by a tone engraving below. It is constructed by Combustion Engineering, Ltd., of Aldwych, London, on the same principle as the larger stokers made by the same firm and marketed by the Underfeed Stoker Company, Ltd. In operation, the large hopper to be seen in the foreground of the engraving is filled with coal every twelve or eighteen hours, and at the same time the clinker is removed. It is claimed that a cheap coal can be used in place of the more usual anthracite, owing to the fact that the fuel is constantly in motion, so that it is intimately mixed with the combustion air. From the hopper the coal is fed by a spiral conveyor, into the bottom of the furnace. A small electric motor drives the conveyor and the supply of coal and air is controlled by a thermostat in the heated water outlet. The "Robot Fireman," as the stoker is called, is made in eight sizes, suitable for burning from 45 lb. to 350 lb. of coal per hour.



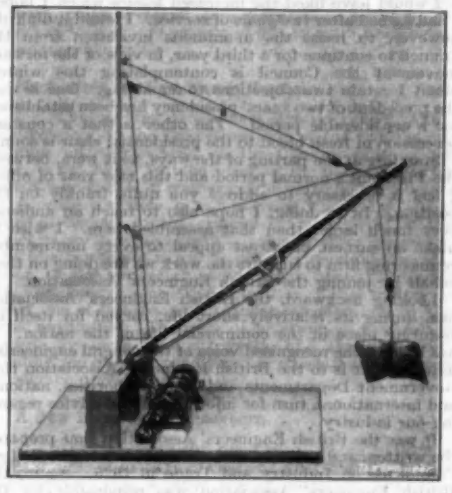
SMALL MECHANICAL STOKER

Combined Winch and Derrick.

WE illustrate in the accompanying engraving a working model of a new combined winch and derrick system which is being manufactured and developed by Clarke, Chapman and Co., Ltd., of Gateshead, by arrangement with the inventor, Mr. George T. Macfarlane, who has already designed other successful slewing winches built by the firm. As will be seen from our illustration of the model, the system comprises a special three-drum winch which is so designed that it can be operated by one man, who has complete and simultaneous control of the slewing, lifting, and topping motions.

Slewing is effected by the combined small barrels C and D, placed at the back of the main barrels, and so arranged that while there is a common drive, one pays off, while the other winds on. Attached to them are the free ends of the slewing ropes C and D, which are rigged with blocks and pass over a swivelling cross tree on the main derrick arm. By rotating the drum shaft, the derrick arm can be slewed in either direction, either port or starboard to an extreme position at right angles to the vessel's side. The two main barrels A and B are independently driven, a being employed for lifting and B for topping, as shown in the model. The controls are such that the hatch can be plumbed in any position. Our illustration only shows a preliminary model, but in the finished gear all controls will be suitably arranged for the most convenient handling by one winch man.

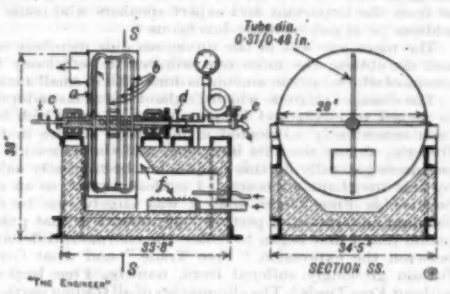
The advantages of this new cargo-handling device can be briefly summarised as giving a saving in labour, saving in time of loading and unloading, and safe handling of fragile cargoes owing to the more perfect and simultaneous control which the winch man has over all the motions of his load. We hope to have an opportunity of inspecting and describing at a later date the actual winches, which are now being constructed at Gateshead on the new principle we have described.



MODEL OF COMBINED WINCH AND DERRICK

A Rotary Boiler.

THE accompanying illustration, reproduced from the pages of our American contemporary *Power*, shows the construction of a model of a boiler which is being developed by a German company, the Gesellschaft für La Mont-Kessel und Kraftwirtschaft m.b.H. The boiler combines the functions of the feed pump and the steam generator. Water is fed by gravity into the hollow central shaft through the stuffing-box *c*, at the left of the drawing. Thence it can pass to radial tubes *a*, which are insulated to prevent the heat from the gas jets *f* generating steam. Since the shaft and the radial tube system is rotated at high speed, the water is forced outwards by centrifugal action and enters the system of four parallel radial tubes *b*, in which steam is generated. The water being very greatly heavier than the steam, volume for volume, the two legs of the U formed by the radial tubes are unbalanced and, consequently, the water drives the steam through the passage in the central shaft and the stuffing-box *d* to the outlet at *e*. The pressure of the steam produced is very nearly equal to that generated in the water by centrifugal action. In the present model the shaft is rotated by an electric motor at speeds up to 2200 r.p.m. and the steam has a pressure of 425 lb. per square inch absolute. It is suggested that a full size boiler could be driven by means of a small steam turbine by the steam produced at high pressure, so lowering the pressure to that suitable for the main turbines of the power plant. The claim is made that a boiler designed on these lines would be very much smaller for the same power than an equivalent water-tube boiler of modern design.



SECTIONAL VIEWS OF MODEL ROTARY BOILER

SPECIAL travelling concessions have been announced by sixteen European countries to their buyers proposing to attend the British Industries Fair in London and Birmingham next February. Railway fares to and from the Fair will be reduced by an average of one-fourth to those presenting special travel vouchers in the following countries :—Austria, Belgium, Bulgaria, Czecho-Slovakia, Denmark, Germany, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Roumania, Switzerland, Turkey, and Jugo-Slavia, most of which have State railways. These reductions are linked up over the British railway companies' systems operating from Continental ports. British buyers will in future be given reciprocal facilities by British railways when visiting the above foreign countries which make concessions to the buyers visiting our own Fair. Reduced fares are also announced over the majority of the passenger steamship services on the Scandinavian and Northern European routes. The air services are also making reductions.

The British Engineers' Association —in Retrospect and Prospect.*

My first duty is to thank you for electing me as your President for a third year. I appreciate very much the honour you have done me, and will endeavour to justify the trust you repose in me.

I would have liked the increased leisure which I hoped I had earned after two years of service. I found it difficult, however, to resist the unanimous invitation from the Council to continue for a third year, in view of the forward movement the Council is contemplating this winter, albeit I retain two objections to remaining. One is that the precedent of two years' presidency has been established for a considerable period. The other is that a constant succession of fresh blood to the presidential chair is sound.

Standing at the parting of the ways, as it were, between the President's normal period and this new year of office, I feel it necessary to address you quite frankly on the position. In so doing, I hope also to reach an audience very much larger than that assembled here. I wish to make an earnest broadcast appeal to every non-member engineering firm to support the work we are doing on their behalf by joining the British Engineers' Association.

Looking backward, the British Engineers' Association has, during its relatively short life, carved for itself an enduring place in the commercial life of the nation. It has become the recognised voice of the general engineering industry. It is to the British Engineers' Association that Government Departments and other authorities, national and international, turn for information and advice regarding our industry.

It was the British Engineers' Association that prepared the written, and gave the oral evidence, before the Balfour Committee on Industry and Trade in 1925. Again, the British Engineers' Association was responsible for the monograph prepared for the Economic Conference of the League of Nations in 1927. Incidentally, that Monograph on the Economic Situation of British Engineering Industry was generally conceded to be one of the finest documents presented to the Conference.

The Empire Exhibition at Wembley had to thank this Association for an enormous amount of help towards making it such a marvellous illustration of British engineering development, and it continues to render the same kind of useful assistance to the Shipping, Machinery, and Engineering Exhibition.

Its ideals as to the service it can render to the commercial side of engineering have continuously grown, under the expert guidance of our Director, Mr. Bremner. The useful information periodically appearing in the *Bulletin*, representing, as it does, a great amount of diligent work on the part of the Director and his staff, is everywhere recognised to be most valuable. Nowhere else can we find statistics grouped together so well and clarified for us so efficiently as in the *Bulletin*.

The advice which our staff is able to render to all our members in regard to the appointment of agents abroad, on the trade position in the Empire and abroad, and in many other ways, is not equalled by any other organisation. The advertising value of the Handbook is increasingly appreciated, both by our members and the large number of recipients at home and abroad who make use of it.

Where are our members and guests able to hear such excellent and useful addresses on British trade generally as from the important and expert speakers who come to address us at our monthly luncheons ?

The more one sees of the numerous aids members can and do obtain, the more one admires the efficiency by means of which such an amount is done with so small a staff.

The changed attitude which England has at last adopted in regard to tariffs and Empire policy is one which has been consistently advocated in numerous articles in the *Bulletin*, almost since its inception, and the education of engineers generally on this subject has been greatly aided by this trenchant advocacy. I confess myself, as an old believer in Free Trade, that it was largely due to the constant reiteration of pertinent arguments in that publication that I first began to realise the enormous difference between the expression "Free Trade" and what Great Britain growingly suffered from, namely, Free Imports without Free Trade! The elimination of all trading barriers, which is the only proper conception of Free Trade, is an ideal which most of us would like to see reached, but the urge towards tariffs has come increasingly since the war by the application of outside forces. No country can continue to admit freely all manufactured goods from countries which, in return, set up barriers against the receipt of its manufactured goods, and live.

We have seen these forces operating increasingly against us until we were driven, in self-defence, to take up the position which, with the elimination of all trade barriers, would not have arisen. In conference and negotiation with all of the other trading countries of the world we are stronger now, not weaker.

This great fiscal change has brought the British Engineers' Association into a more prominent position, because it has been found to be the only organisation or association in a position to speak and act for the general engineering industry as a whole in connection with tariff matters. For this reason it has been entrusted by the Import Duties Advisory Committee with the responsible duty of assisting it to exercise effective control over applications for the exemption from duty of imported machinery on the plea that such machinery is not procurable in this country. The functions of the British Engineers' Association in this respect extend to all kinds of machinery other than electrical machinery and machine tools, which are similarly dealt with by their appropriate associations. It will be realised that the bulk of the work necessarily falls on the British Engineers' Association, and that a considerable amount of time and thought have to be given to the investigations preceding the preparation of a report on any given application. The benefits of this work are by no means confined to the members of the British Engineers' Association. In performing this public duty no distinction is made between members and non-members, and I suggest that the value of this work is worthy of recognition by engineering firms who do not yet support the Association.

Everyone who has thought the matter out so far agrees, however, that the Ottawa Conference is but a beginning. Manufacturing firms who are members of this Association, whether producing prime movers or accessory machinery of any kind, are so far assisted very little, on the whole, in their endeavours to improve the export position in relation to our Dominions; and in regard to foreign countries not at all. Dominion Tariff Boards will be appointed to deal with numberless detail problems. Who should be the spokesman for the British engineering industry ? What organisation should it be but the British Engineers' Association; and yet, when we look at it, what do we find ? An Association with a few hundred members, which ought to be vastly increased. An Association capable of rendering immense help even now, but which, when properly supported, could greatly increase the assistance it could render. When I had to reply, as your President, to an invitation—conveyed to us in a recent speech by Mr. Colville, the Parliamentary Secretary for Overseas Trade—to send an engineering expert to Canada to assist in preaching the gospel of the excellence of British engineering goods in that great Dominion, I had, in declining, to use these words :—

> "The British Engineers' Association has an excellent organisation. It is giving wonderful service to its members. There is no comparable organisation which can effectively take its place as representing British engineering, *but, at the present time, while any industries are very glad to take advantage of its help, the amount of active support which it receives—and, therefore, the total revenue which it has—is too small to justify the Council in undertaking the heavy financial responsibility which would be involved* in carrying out the plan on a scale which they consider would be necessary to provide an organisation which would be really satisfactory."

What really is the position ? The British Engineers' Association has a name which ought to stand for a great deal more than is at present possible. The British Engineers' Association has an efficient and well-informed Director, well received in all circles and well qualified to speak, as he does, for British engineering trade. It has a sound framework capable of great expansion to the benefit of British trade. Its membership and its financial strength are insufficient to enable its great possibilities to be fully realised. It reminds me of the horse referred to in one of Mark Twain's inimitable anecdotes. After describing it he said : "This horse had many good points, and on one of these I hung my hat. !"

This excellent framework of our organisation must be strengthened in order to make the British Engineers' Association capable of achieving all its aims. The framework must be amply clothed with flesh. It must have a vigorous supply of healthy blood coursing through its veins. I feel now is the psychological time for us to make a definite move forward, and it is up to us, as members of this Association, to take this work in hand.

One of the many aphorisms which Americans use is pertinent. It is this. "He who by his trade would rise, must either bust or advertise." Put more pithily, our neighbours across the Atlantic preach the doctrine of "Get on or get under !" I feel strongly that now is the time for us to "get on," if we are not to go under. Has not our immortal Bard, William Shakespeare, said : "There is a tide in the affairs of men, which, taken at the flood, leads on to fortune." I feel that in the present circumstances, with engineering commerce looking for leadership in its struggle with new and difficult conditions, bold steps must be considered and taken by the Council and members of this Association to increase its growth.

During the last two years one of the important advances we have made has been that of the subdivision of our membership into groups. We have a group of internal combustion engine makers, another of pump makers, a third of refrigeration machinery makers, and others are in early prospect. That should be only a beginning. Why should we not aim at making the *British Engineers'* Association, in actual fact, what its name implies ?

Specialisation in British engineering is immense. How can the advantages of membership in our Association be put to all these specialist manufacturers who are not with us, so that these engineering groups can be greatly extended ?

Again, there are other powerful associations dealing with specific branches of the engineering industry, doing useful work for special trades. How should our advance be planned with relation to them, so that all efforts in the interests of British engineering can be co-ordinated ?

Though not so obvious as the ghastly destruction of capital as well as life, due to the fearful cataclysm through which the world passed in 1914 to 1918, the post-war period has seen tremendous losses in capital. Confidence has been greatly diminished, if not, in some cases, lost. The great manufacturing countries find themselves over-equipped, due to their war efforts, and therefore competing intensely with each other for the supply of that diminished quantity of manufactured goods which the world can still afford to buy. Barriers have been erected between nation and nation, or increased in height, so that the flat race in economic production has become an obstacle race.

Dire though our position is, we at least can be thankful that it yet compares favourably with that of other nations; and yet, what is that position ? Insensate competition between individual firms and groups, so that the last trickle of that profit which should provide the life blood of our industries is disappearing.

Cannot this Association become the spear-head of a national endeavour to reorganise our mechanical engineering industry, so that when the tide of foreign demand returns, as return it will, we shall secure that share which our native skill and experience justifies ?

I visualise the British Engineers' Association of the future as a great body representing all branches of manufacturing engineering, organised under their specialised groups with their own chairmen, who, as long as they hold that office, will be *ex officio* members of the Council.

The Director can direct, but he cannot do all of this increased work personally. Additional assistance, however, would enable him to supervise the work of this increased number of groups. Our Council would have the work of the groups reported at each meeting by their own chairman, and the groups would thereby be sufficiently effectively decentralised, and yet centralised under the Council so as to make the Association a far greater power, far more capable of speaking for the whole of the vast manufacturing engineering industry than it is at present.

Is this only a dream ? Is the Association content merely to exist, or can we not organise ourselves, bringing more enthusiasm to our duties, so as to make the British Engineers' Association what its name implies ?

I believe such a step is necessary. I believe that by proper missionary work in the provinces and with the assistance of the Press—which, I am sure, must recognise the need for a body to speak for mechanical engineering on its commercial side—the British Engineers' Association can be, and ought to be, as powerful on that side of our work as the Institutions of Civil Engineers and Mechanical Engineers are on the scientific and educational side.

During my presidency of the Institution of Mechanical Engineers I was proud to be able to announce at our annual dinner that the membership of that Institution alone had passed the ten thousand mark. Why should not our own Association seek and achieve that same outstanding position on the commercial side ?

I have told you what we have done in the past. I have told you of the growth we have made, and I have painted a picture to you of what I think, in the interests of engineering trade and our country, the British Engineers' Association might become. Are we prepared to "put our hands to the plough" and not desist until we have achieved it ?

* Address read by the President of the British Engineers' Association, Mr. William Reavell, at a luncheon on November 9th in London.

Imprisoned Air and the Failure of Castings.

By J. G. KENNEDY.

THERE has been and is still a certain amount of controversy over the effect of air imprisoned in castings subjected to hydraulic pressure. For instance, whilst under static test and working conditions, many hydraulic castings have failed. In many instances no flaw is apparent in the metal, and the usual conjecture is that imprisoned air, subjected to pressure, has been the cause of failure. Granting this, we have, however, the fact that the air imprisoned is subject to the same pressure as the liquid contained in the vessel. It is, further, a notable fact that whilst the casting is in itself quite capable of withstanding the pure hydraulic load for which it was designed, the addition of a quantity of air will in many instances be quite a sufficient cause for fracture, or, at the very least, a collapse of the seals, whether they are composed of gutta-percha or hemp packing. It is obvious to suppose that a casting designed to withstand a pressure of 750 lb. per square inch of hydraulic load would be quite capable of containing, to that pressure, any air that might be imprisoned therein. This, however, is not so, as there have been many instances of castings failing whilst in use, although having previously withstood a test pressure of 2500 lb. per square inch pure hydraulic pressure.

The following theory has been formulated, therefore, in an attempt to inquire into the cause of the rupture of pressure castings owing to compressed air. Consider the casting itself. In the first place, we are aware that in an ordinary iron casting there is a high percentage of initial stress, part of which cannot be computed, but for which allowance is made as closely as possible when the casting is designed. To fracture the casting therefore we may take three probable causes :—(1) A violent blow, (2) extreme heat, or (3) extreme cold. Either of these will combine with the already present initial stresses to cause a fracture. In dealing with the subject in hand, however, we may ignore two of these causes and deal only with heat. The writer has over a number of years been studiously observing, with a view of forumlating a theory, castings which have fractured through the presence of imprisoned air when subjected to hydraulic pressure. An examination of many of these failures showed, however, no evidence of a flaw in the affected part which would, no doubt, have been perfectly capable of withstanding the load had the air element been excluded.

We are all aware that air subjected to pressure compresses in conformity with Boyle's Law; and, further, generates heat in conformity with the speed of the application of the load. Therefore, suppose that 1 cubic foot of air be imprisoned in a casting subjected to the usual hydraulic working pressure of 750 lb. per square inch. Taking into account the already present atmospheric pressure of 15 lb. per square inch, it is apparent that 1 cubic foot of air, subjected to 750 lb. per square inch, will occupy only 1/50 of the space occupied at atmospheric pressure. It has been observed in many instances that a casting will fracture only in accordance with the method of the application of the hydraulic load. Thus, a fracture is more likely to occur when the load is applied with suddenness than when applied with discretion. This leads to the deduction that heat is one of the prime causes of fracture. When the load is applied to the imprisoned air slowly, heat is generated isothermally. In many instances, and to all practical purposes, no damage is apparent in the casting. On the other hand let us assume that the load is applied suddenly. The air is then compressed adiabatically and the heat generated, combining with the already present initial stresses, gives rise to a stress which is sufficient to overcome the cohesion in the iron, and a fracture results.

In support of this view, we have the theory applied to the Diesel engine, wherein heat sufficient to ignite the injected fuel is generated adiabatically. In the present-day Diesel engine, especially in the small, fast-running type, the ignition temperatures in some instances are as high as 1200 deg. Cent. These temperatures are obtained by high-speed compression, with a ratio of approximately 19–1, and at a pressure of approximately 500 lb. per square inch. We may therefore assume that air imprisoned in a casting and subjected suddenly to a load of 750 lb. per square inch and compressed to a ratio of 50 : 1, will generate a temperature far in excess of that in a Diesel engine.

To support this theory further, the sudden release of compressed air has a refrigerating effect, and a close observer will note when a casting bursts under the hydraulic test a spray of air in the form of vapour, and a slight frosting in the immediate neighbourhood of the fracture. This frost disappears immediately, but an

appreciable difference may be noted in the temperatures of the metal surrounding the fracture and the metal which has been subject to hydraulic pressure only. That part which has been subject to air pressure is noticeably warmer. It has also been noted that, when the imprisoned air has escaped through a gutta-percha joint, the substance shows evidence of having been subjected momentarily to heat which caused it to soften. It had then re-formed solidly on the air escaping and immediately lowering the temperature. Further, it has been observed that a joint of this description will allow air, but very little water in comparison, to escape. This fact seems to support the theory that the heat generated by the air causes a softening of the substance, which the refrigerating effect of the escaping air immediately counteracts.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improvement Maintained.

THE stronger trade position in Midland and Staffordshire industries is upheld, and although there has been no important development in the situation during the past week, it is evident that more solid ground is gradually being provided on which manufacturers can build. Even in the heavy industries, which have been depressed for so long, there is evidence of a healthier state of affairs. The small increase in buying of iron and steel alike on home and export account is all to the good, and prospects of securing business once placed with Continental rivals become better each week as stocks at the works become smaller and foreign prices show no sign of declining. There was quite a cheerful tone on the Birmingham Exchange this week and considerably more interest was displayed than was the case, say, a month ago. The volume of inquiries in circulation has advanced materially, while buying is inclined to be on a freer scale. In some cases consumers of iron and steel appear to be debating the wisdom of getting in some supplies against the possibility of higher prices. There is not much evidence of greatly improved consumption except perhaps in one or two of the lighter branches of trade, but it is firmly held that the tendency towards progress is real and that an increase in business all round is to be expected in the immediate future. There is, generally speaking, a brighter aspect towards trade possibilities, and definite help is looked for as a result of the inter-Empire agreements and the curtailment of foreign competition.

Healthier Trade Figures.

Midland industrialists are encouraged to further cheerfulness by the overseas trade record of October. The volume of business showed a distinct improvement over that of September, though it was still substantially below that of October, 1931. It is pleasing to note that nearly three-quarters of the four million pound rise in exports is accounted for by articles wholly or mainly manufactured, the total under this heading for September being £19,750,987, while for last month it rose to £22,677,141, an advance of £2,926,154. The total of British exports for the month was £30,440,149, compared with £26,228,666 for September. On the other side of the account there was an increase in imports over September of £6,561,412, which was mainly due to larger imports of food, drink, and tobacco. What is distinctly cheering is that, in comparison with last year's figures, October trading represents a decrease of £19,858,060 in imports, £2,392,193 in exports, and £1,584,102 in re-exports. The excess of imports over total exports being thus brought down from £42,577,114 a year ago to £26,695,349 last month. Taking the year to date, exports show a net reduction compared with last year of £23,675,318, and re-exports are down £10,811,402, making the total reduction of exports £34,486,720. In comparison with this imports have declined by nearly £121,000,000 and the visible adverse balance has been reduced on the ten months by £86,488,000. Taken in conjunction with the encouraging fall in unemployment recorded recently, these figures warrant brighter trade hopes. True, the trade returns and the unemployment statistics will have to continue steadily in the right direction before complete reliance can be placed upon their testimony to a trade revival. Nevertheless, there now seem to be foundations sufficiently strong to justify industrialists in their optimistic outlook towards the future and their anticipations of improved trade.

The Call for Steel.

Although it must be immediately conceded that consumption of steel grows so slowly as to be almost imperceptible, it is nevertheless certain that steel masters are busier and the industry shows more life than for some time past. Local steel masters have booked small orders, which they have reason to believe would have been placed abroad if prices on the Continent had not appreciated to such a substantial degree. For a month past purchases of foreign steel by Midland users have practically ceased, and as stocks at works have declined, local steel masters have been receiving inquiries and in some cases orders for small quantities urgently needed. There are evidences that price cutting by the foreigner in this market has brought him to such a state that he is now compelled to pause and consider the wisdom of keeping up what must now in face of a two years' protection policy for the British steel master seem the almost impossible task of maintaining the large measure of business secured in recent years. There is a feeling in steel circles here that the struggle is not yet over, but steel masters have not the same fear of foreign competition as they had before tariffs were imposed. They realise that no manufacturer can go on selling at a loss indefinitely and they hold that to secure this market now the foreigner will certainly have to give up all chance of profits from business transacted with this country. Local steel works are decidedly out to make the most of the new situation, and they do not hesitate to advise consumers to get into touch with them while the going is good. Particularly is this the case with consumers of half-products. In the finished material branch the majority of users have for some time past been confining themselves to the purchase of native steel and have participated in the rebate scheme instituted by the Steelmasters' Association, which gives preferential terms to those who buy only British. There has, as one may readily understand, been little change in the finished steel demand here as the result of the Continental position, but even this branch is likely to benefit to some extent if the foreigner gives up the struggle. Steel masters are maintaining their selling rates on recent levels, thus giving confidence to the market. Angles sell at £8 7s. 6d. per ton, less 15s. rebate; tees at £9 7s. 6d., less 15s.; joists at £8 15s., less 22s. 6d.; and ship, bridge, and tank plates are £8 17s. 6d., less 15s. Sales of boiler plates are made at £8 7s. 6d. to £8 10s. Staffordshire re-rollers hold out for £6 15s. per ton, at the least, for small bars re-rolled from Belgian billets. In a number of cases they ask half-a-crown more. They find business improved and orders more regular. For all-British bars makers want £7 upwards. Soft billets are unaltered at £4 17s. 6d. to £5 7s. 6d., sheet bars at £4 15s., and Staffordshire hoops at £9 10s. Steel masters note that during October the output of steel ingots and castings expanded to 438,500 tons, compared with 430,300 tons in September and 457,400 tons in October, 1931.

Rolling Stock Order.

As I write news comes to hand of a substantial order received by the Gloucester Railway Carriage and Wagon Company which will keep them occupied for the greater part of the next six months. I am led to understand that it will probably provide employment for between 100 and 200 men additional to the present *personnel*. The order, placed by the Southern Indian Railway, is for twenty-one trailer and non-trailer coaches, which will constitute three trains of seven coaches each. The value of the order is said to be somewhere between £50,000 and £75,000.

Raw Iron.

Midland smelters of pig iron are having slightly larger calls made upon them, especially for foundry grade iron. Although specifications are practically all for small tonnages, they are more regular. Blast-furnacemen state that there is some broadening of contracting on forward account, which is either an indication of more confidence in the foundry industry or of precautionary measures against possible higher values being adopted. Quite a number of firms have now departed from the policy of hand-to-mouth buying, in which they persisted for a very long time. That there has been some expansion of business during recent weeks is evidenced by the returns of production for October, which show an improvement over September of 15,200 tons. Output in October amounted to 275,600 tons, against 260,400 tons in September and 284,200 tons in October a year ago. There was no change in the number of furnaces in blast at the beginning and the end of the month, for although two had been blown out two others had been recommissioned. The makers of light castings are responsible for a large proportion of the pig iron output, general engineering interests being poorly represented. Prices remain on the same level, namely, £3 2s. 6d. for Northamptonshire No. 3 foundry pig and £3 6s. for Derbyshire delivered to Black Country stations and subject to rebate according to the quantity ordered. Forge iron values are likewise unchanged.

Finished Iron.

The situation in the Staffordshire finished iron trade is dull and uneven and there has been no change for the better during the week. I might add, however, that there does not appear to have been any change for the worse either. Intermittent working is a necessity at most of the works. Demand is fitful. The better reports from some of the consuming industries lead ironmasters to hope for an extension of business, but the outlook is far from promising, at any rate to the end of this quarter. There has been no alteration to prices. Marked bars are named £12 at makers' works, Crown bars £9 upwards, nut and bolt bars £8, fencing bars £7 15s., and wrought iron tube strip £10 7s. 6d. to £10 10s. delivered.

Galvanised Sheets.

Galvanised sheet mills in this area are fairly well employed and the inquiries to hand from overseas lead to the belief that there will be a continuance of the present conditions. Indeed, some further expansion is expected when ratification of the recent settlements with India has been made. Producers are holding to the scale of selling prices fixed for the home trade and are also quoting firmly the £10 level for export business in 24-gauge galvanised corrugated sheets. The automobile engineering firms are taking more black sheets than they were, and in this department also there is cause for some satisfaction in the course of trade. Quotations are on the basis of £9 5s. for 10-ton lots with a rising scale for smaller tonnages.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Less Unemployment.

LANCASHIRE still ranks among the English counties with the highest rate of unemployment, but it is well below the worst situated in this respect, and the latest official returns show a reduction compared with the previous month of 2·5 per cent. This favourable movement is probably due, in the first place, to an improvement in cotton trade conditions, although the position among the general engineering trades is slightly better on the whole than it was. The incidence of unemployment in Lancashire and Cheshire has the wide range of 8·1 per cent. in the most favourably situated area to 46·2 per cent. in the worst. At the lower end of the scale are such smaller industrial centres as Irlam, Lancaster, Leyland, Atherton, and Prescot, with Blackburn, Wigan, Birkenhead, Darwen, and Stalybridge ranking high from the point of view of unemployment at the other end. Manchester itself is relatively well placed, the percentage being 16·6, the adjoining city of Salford having a return of 25·7 per cent., with Liverpool as high as 29·7 per cent. The intermediate positions are occupied by Widnes, Ashton-under-Lyne, St. Helens, Accrington, Oldham, Stockport, Leigh, Bolton, Burnley, Hyde, Rochdale, Horwich, Bury, Preston, and Warrington, all of which, in varying degree, are centres of one or more branches of the engineering trades.

Ventilating the New Mersey Tunnel.

The opening of the new Mersey Tunnel, which has Liverpool on the Lancashire side of the river as one terminus and Birkenhead on the Cheshire side as the other, is not likely to take place in the near future, for there is a good deal of engineering work to be done before the enormous system of ventilation, which has added about £1,500,000 to the original estimated cost of the tunnel, is completed. There is some question, however, as to whether or not it will be possible, pending the completion of the ventilator contracts, to open the tunnel with temporary ventilation facilities. The matter is largely one of finance, and is under consideration by the tunnel authorities. The work of construction has been in progress for more than six years, and the total cost, including the extra expenditure on ventilation, will be in the neighbourhood of £7,000,000.

A New Industry for Blackburn.

Welcome news for Blackburn, whose industrial interests are primarily concerned with cotton, is the announcement that a large firm of electrical appliance manufacturers, with headquarters in Canada, has taken over part of an extensive mill in the town for the manufacture of equipment. It is expected that employment for several hundred people will result.

Co-ordinating Electricity and Gas.

Under the title of the Lighting, Heat, and Power Committee, the former Lighting, Electricity, and Gas Committees of the Salford Corporation have now been placed under central control, and practical economies are expected to result. Three sub-committees have been set up to deal with the special problems of lighting, electricity, and gas, and under the new arrangement it is hoped to avoid a good deal of the overlapping and the conflict of interests which were formerly experienced.

Non-ferrous Metals.

The past week has witnessed an expansion of buying interest in the non-ferrous metals market, although much of it has been speculative in character. Following upon the upward movement reported a week ago in all sections of the market, steady to firm conditions have ruled in all cases, with the exception of copper. In this metal there has been a certain amount of reaction, but the loss on balance has been fractional, and for all practical purposes it is correct to state that the advance has been virtually maintained. Standard brands of copper are cheaper compared with a week ago by about 5s. per ton, but there has been little change in the price position of refined descriptions of the metal. The effect of the improvement in values has been to increase the turnover substantially. The demand for tin from industrial consumers has shown little expansion, but there has been a moderate display of speculative buying interest, and quotations have added about £1 5s. per ton to the advance recorded a week ago. There has been no further upward movement in either lead or spelter, but the position of both these metals at present appears to be very steady, and at the moment of writing values are well held at the levels current a week ago, and a fairly active business has been reported.

Iron and Steel.

In the iron and steel markets on this centre, the general undertone continues to be rather more hopeful, and the view is that the worst of the depression has been left behind. Unfortunately, so far as the position of the principal heavy consuming industries in Lancashire is concerned, there is still a pronounced shortage of work, especially among constructional engineers, whose hopes for the future are largely bound up with a relaxation of the restrictions upon expenditure on public works. Among forge masters and also among sellers of alloy steels a better inquiry has been experienced of late, and more actual business has been done. Both these factors point to some degree of improvement among the general engineering trades. Machine tool makers are still indifferently employed for the most part, but the position of textile machinists is believed to be slightly better than it was. In the case of the latter branch of engineering, orders have been reported during the past week in connection with cotton mills in Persia, and more business from this direction is expected. In the meantime, contract buying in all sections of the markets is very small indeed, and new orders in iron and steel are restricted to near deliveries, conditions which are expected to continue over the remainder of the year. For delivery to users in the Manchester district, Derbyshire and Staffordshire brands of No. 3 foundry iron are quoted at 67s. per ton, Northants at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at about 83s. 6d., and West Coast hematite at round 81s. In the steel section, joists are at £8 15s. per ton, sections at £8 7s. 6d., ship and tank plates at £8 17s. 6d., boiler plates at about £8 10s., and small re-rolled bars at about £7.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron market remains unaltered, and business continues on restricted lines. Stocks still remain at various works, but at places where furnaces have been idle for some time they are gradually dwindling. Up to the present there is no information as to the putting in of any more furnaces, but

it is hoped that Barrow will start producing again shortly. When the furnaces are once more active at Barrow it is more than likely that the rail mills will get to work again. Business outside this country is still on the dull side, and there are few inquiries as yet. The iron ore trade remains very quiet as regards both native and foreign sorts. The steel market does not show signs of revival as yet, although some orders are held, but there is no immediate request for delivery of rails. The hoop section is experiencing a regular demand, and this fact is no doubt due to the rate of exchange, which permits prices to be quoted abroad which are successful in competition with those of makers in other countries.

SHEFFIELD.

(From our own Correspondent.)

Cold Rolled Strip Production.

WHILST serious depression continues in the heavy iron and steel industries, with at the same time a more confident tone and some ground for optimism, business continues to expand in certain steel specialities, and at one works producing cold-rolled strip overtime is necessary to cope with the rush of orders. Conditions also continue brisk in magnets and safety razor blades, and requirements for the automobile industry are providing work for various establishments. Some improvement has taken place in the market for ferro-alloys, used extensively in steel making, and transactions have increased, though not to the scale which formerly obtained.

Scandinavian Trade.

Sheffield is making a bid for an improved share of the trade of Norway, Sweden, and Denmark, and for this purpose is sending its own trade commissioner, Mr. F. C. Fairholme, who will go as a member of a delegation organised by the National Federation of Iron and Steel Manufacturers. Mr. Fairholme, who has for many years occupied an important position in Sheffield industrial circles, has been nominated by the Sheffield Industries Overseas Trade Committee, and will look specially after the interests of Sheffield trade. Statistics show that both the heavy steel industries and the lighter trades of Sheffield have a considerable potential market in the Scandinavian countries, and if, as a result of this delegation, agreements can be reached, orders to Sheffield industries will be forthcoming. Following the Ottawa Conference, we are now in a position to bargain with foreign countries as to the treatment which British goods shall receive in their markets. The State-owned Danish railways buy practically no material from this country, and if the Danish Government can be persuaded to give us a share of railway orders, it will mean that Sheffield firms will get contracts for springs, tires, buffers, wheels, axles, and other products. There is a field also for a great increase in the tool trade. At present the Danes purchase nearly all their tools in foreign countries.

Cutlery and Plate.

Compared with a year ago, special Christmas season orders have been on a reduced scale, and will be completed in a week or two. The output of sterling silver goods and best plated hollowware is poor for the time of the year. A considerable quantity of spoons and forks is being sold, and chromium-plated and stainless steel spoons and forks are steadily growing in favour. No considerable increase of trade has followed the removal of the Australian embargo on the importation of silver and plated hollowware, but Sheffield firms interested in the market have been shipping samples and stocks to the Commonwealth.

Stainless Steel for Egg-breaking.

Some curious and unheard-of uses of stainless steel are revealed from time to time. China is a big exporter of yolks and whites of birds' eggs, which are first broken in a special machine by means of a steel blade measuring about 4in. long and ¾in. wide. Recently the buyers of these blades specified that they should be of stainless steel, because the ordinary steel previously used soon perished through contact with the yolks of eggs. A Sheffield firm which specialises in machine knives and small cutters has executed several orders for these stainless knives, one of them for more than 10,000. Inquiries have also been received from the same sources for stainless steel pans to hold egg whites and yolks.

To Help the Steel Trade.

As shipbuilding holds the key to the solution of the troubles in the heavy steel industry, special interest attaches to an idea propounded by Mr. Ronald W. Matthews, a former Master Cutler and President of the Sheffield Chamber of Commerce. To-day, lying idle in docks all around our coast, are to be found 2½ million tons of shipping Part of this is more or less overdue for scrapping, and part, because of the great strides made in shipbuilding development, is unable to compete favourably with the most modern vessels in the present depressed freight market. Because of the low figure obtainable for scrap metal to-day, the shipping companies find themselves unable to release their obsolete vessels for breaking-up purposes. What is wanted is some means of bridging the gap between the present low price of scrap metal, namely, roughly 35s. a ton, and that of 70s. a ton, which represents the normal value. It is suggested that some 2 million tons of shipping should be scrapped and replaced by 1 million tons of new shipping. Taking this figure of 2 million tons, and assuming a difference of 35s. a ton as between present and normal prices of scrap, it will be seen that a sum of £3,500,000 would be necessary as some sort of guarantee to the shipbreakers, and it is thought that this might be provided by the Government. It is not intended that such a transaction should be a subsidy, because the rise in price of scrap metal which would take place automatically with increased steel trade and activity would eventually enable the repayment of the guarantee.

Steel Enterprise.

Edgar Allen and Co., Ltd., of Sheffield, have just put on the market a new alloy steel for blacksmiths' and kindred tools, chisels, &c., while another line that they are developing is heat and corrosion-resisting fire-bars. A novelty recently manufactured was a stainless steel axle for a motor boat, which runs in phosphor-bronze bearings under severe conditions, and the owner now reports that after running for 600 hours it showed no signs of wear.

Progress of Greek Scheme.

Excellent progress has been made with the important contract upon which Henry Boot and Sons, Sheffield and London, are engaged for the Greek Government. The surveys and preliminary studies have been completed and have been accepted by the Government. These preliminary studies are in respect of great tracts of country in Boetia, Thessally, Epirus, and Creta. The reclamation and irrigation of these large areas of productive land have been shown to be of immense potential value to Greece, and the drainage of malaria-infected districts will also bring great benefits. The final studies in respect of these works, which involve the preparation of the designs and estimates of cost for the actual works, are now proceeding, and the firm hope is expressed that the Greek Government will decide to proceed with constructive work in some areas in the early spring of 1933.

Floods Prevention Work.

No Government grant is to be made towards the cost of the work now proceeding at the Grand Sluice at Boston to prevent the flooding of 250,000 acres, including parts of the City of Lincoln. In the application for a grant, the total cost was estimated by the Witham Catchment Board at £12,700, spread over three years, but it is now expected that the total expenditure will be considerably greater.

Grimsby Fish Dock Construction.

Considerable progress has been made with the construction of the new fish dock at Grimsby. The site on the foreshore of the Humber covers an area of 175 acres, of which 37 acres are to be water area and the remainder for industrial development and siding accommodation. The necessary reclamation embankment has been completed, and the construction of the new lock and entrance pier is in progress. The excavation work for the dock is well advanced, and a large area of the reclaimed site has been filled in behind the new river embankment. Extensive railway sidings have been laid down and the construction of the new quays in reinforced concrete is nearing completion. The features of the new dock include 4000ft. of additional quays, six coaling appliances, two outfitting jetties with heavy-lift cranes, and ten slipways.

Leeds Housing Policy.

The Leeds Corporation is to consider a proposal for the building of approximately 194 working-class houses to be let at 4s. 6d. a week, exclusive of rates.

Wakefield Electricity.

In spite of the very serious economic and trade depression, the Wakefield Corporation electricity department made substantial progress during the financial year ended March 3rd last. The units sold numbered 13,501,225, which was an increase of 6 per cent. over the previous year. The sales of electricity for power purposes showed an increase of 1½ per cent., but the greatest advance was on the domestic side, where an increase of 11 per cent. for lighting and heating was recorded. The number of new consumers connected to the supply was again a record for any year in the history of the undertaking, being 2251, or nearly double the previous record figure of last year.

NORTH OF ENGLAND.

(From our own Correspondent.)

Famous Forge Closed Down.

THE Darlington Forge Company, Ltd., ceased operations at the week-end—a severe blow to the North-East Coast. Since the appointment of a receiver and manager to the Forge in August last there had been hopes that it might not have to close down, and that it might once again take up the leading position which it held among North-East industrial concerns. Early in August, Sir William McLintock was appointed receiver and manager on the application of the prior lien debenture holders, represented by the English Steel Corporation, whose interests are largely centred in the Sheffield district. Since that time only a skeleton staff has been engaged. The Darlington Forge, which is a world-famous company, has made big forgings for many Atlantic liners, and the Cunard Company has depended entirely upon it for the production of heavy forgings required in the construction of its most important vessels. The Forge had an unrivalled reputation for the manufacture of large and heavy forges, and in recent years had executed much important work for the principal shipyards of the North-East Coast, in addition to carrying out important Admiralty contracts. It is little more than a fortnight ago that the giant castings for the new Cunard liner on Clydeside were despatched from the Forge, and a few months previously the company repaired the rudder of the "Berengaria." It is feared that with the cessation of operations a great deal of the work on big castings will go either North to Clydeside or to the Midlands.

Cleveland Iron Trade.

Demand for Cleveland pig iron is more active than for some months past, and a disposition on the part of some consumers to fix up forward supplies is indicative of confidence in the future. At the moment sales are still mostly to home firms and to buyers in Scotland, but overseas business, while still small, shows a little expansion, and export inquiries encourage the belief that transactions for despatch to foreign ports are likely to be on a much improved scale. The present output is going into immediate consumption, and stocks are being drawn upon to meet commitments. Ironmasters adhere firmly to their fixed figures for the home trade at 61s. for No. 1 foundry, 58s. 6d. for No. 3 G.M.B., 57s. 6d. for No. 4 foundry, and 57s. for No. 4 forge. Purchases for Scotland and abroad can be made at a little below these figures.

Hematite Pig Iron.

Supply of East Coast hematite pig iron continues ample, but both home and Continental demand is just a little better, and there seems promise of further improvement. Merchants still possess a good deal of hematite and are underselling makers to some extent. The latter endeavour to keep market rates at the equivalent to ordinary qualities at 59s., but as terms of contract are a matter of individual bargaining quotations vary.

Ironmaking Materials.

Foreign ore quotations are advancing, but the upward movement is due to higher freights and not to any increase in demand. Rubio ore of 50 per cent. quality is now put at 15s. c.i.f. Tees. Blast-furnace coke is as plentiful as ever and difficult to sell. Good average qualities remain at 14s. 6d. delivered to North-East Coast works.

Manufactured Iron and Steel.

Business in manufactured iron and steel is expanding on an encouraging scale. Continental semi-finished and finished prices have moved upward recently—an event that assists manufacturers in this district to book more home orders. The disparity between home and foreign prices of semi-manufactured material is not much, but it is sufficient to place home producers in a more advantageous position than their competitors, and they report contracts on a fairly good scale. There is an improved demand for constructional steel, though orders are still for small tonnages, and for delivery at short notice. Producers of railway material have contracts to complete, and may secure a good deal of new work, but demand for shipbuilding requisites is as quiet as ever. Some enlargement of output in sheet manufacturing branches is reported. The exports from the river Tees this week included a cargo of 3629 tons of steel for Russia, which is part of an order of 5000 tons placed by the Soviet a few weeks ago. Since the beginning of the year over 12,000 tons of steel have been shipped to Russia from the Teesside district, and still larger orders are expected in the near future. Prices of all descriptions of semi-finished and finished steel are firmly maintained.

The Coal Trade.

There is every appearance of the coal quota for this quarter in Northumberland being severely taxed. Business has come on sharply during the last few days. The collieries are full to the end of the month, and buyers are not able to arrange early turns. Already several steamers have been behind time in loading owing to the pressure at the staiths. Occasionally a few Northumberland pits have been in difficulties before because of the limitations of the quota system, and this unsatisfactory state of things may be repeated unless the quota is raised, as the winter trade seems to have set in on extensive lines. The weather has so far been mild, but should there be a spell of cold conditions the demand for both Northumberland and Durham coals might get right ahead of the quotas for the respective counties. Every preparation should be made to cope with the larger volume of trade that may offer. Northumberland is very busy at the moment, and if it could sell as much small coal as large coal the conditions would be very satisfactory. Nevertheless, the entire production is selling well in graded form. Orders have been placed for shipments up to the end of the year. For this month's loadings turns are difficult to secure, and there are many handy-sized orders circulating for which shippers cannot obtain definite offers, especially for shipments over the next ten days. The general undertone is good. Best Northumberland large steams command 13s. 9d. to 14s., and small remain steady at 8s. 6d. Prime Wear steam are firmly indicated at 15s. for screened and 11s. for small. Tyne prime are sparingly offered at 13s. and small at 9s. Other classes are being well booked at 12s. to 12s. 6d. Increased business and inquiry for every quality of Durham coal gives a more cheerful tone to the outlook. Prices have not yet made appreciable improvement, but the general tendency is steadily pointing that way. Best gas coals are firm at 14s. 6d., and the special Wear qualities at 15s. Secondary gas coals, although still abundant, are more eagerly sought after, and the undertone of the market favours owners, quotations being held to 13s. to 13s. 6d. Coking unscreened and small, after a long period of dull trade, are in more general request, and although stocks are plentiful prices tend upwards. Actual sale prices are, however, unchanged at 12s. 6d. to 13s. 3d. For Durham unscreened bunkers there is substantial pressure for best class, and supplies are difficult to obtain at 13s. 9d. to 14s. Second qualities are quietly steady at 13s. There is a strong inquiry for gas coke. Buyers are numerous, but sales limited to small parcels owing to general lack of supply. Best qualities are firm at 18s. 6d. and vertical make at 23s. Patent oven coke is in fairly ample supply, but quoted steady at 15s., and for favourite brands 16s. to 16s. 6d.

SCOTLAND.

(From our own Correspondent.)

Dock Reconstruction at Greenock.

THE reconstructed Garvel Graving Dock at Greenock was opened last week. The old Garvel Dock, built in 1871, had a semi-circular entrance, while the new entrance is square in section, and the width is 71ft. Under the old conditions the size of ships using the dock

was limited, but the repairing of huge modern ships will now be possible, thereby opening up a comparatively new industry at the port.

Shipbuilding.

The Caledon Shipbuilding and Engineering Company, Ltd., Dundee, has secured an order for a new passenger motor ship from Alfred Holt and Co., Ltd., Liverpool. The vessel is for service between the Straits Settlements and Australia. The propelling machinery is to be supplied by Burmeister and Wain, Copenhagen, and will be installed by the Caledon Company at Dundee.

Bridgework Contract.

A contract of considerable proportions for bridgework for the South African Railways has been received by Sir William Arrol and Co., Ltd., Glasgow.

Steel.

There is a fair volume of inquiry for steel, with export a shade more prominent than of late, chiefly in the lighter descriptions of material. Light steel sheets maintain their recent improvement, the producing plants being fully engaged at present. Heavy gauges are not so well placed. Business in tubes is distinctly better, the works being employed with greater regularity, especially those engaged in the manufacture of small-diameter tubes. The demand for heavy steel is comparatively quiet. Plates are better probably, owing to the Soviet orders recently placed; but sections and joists are quiet.

Iron.

Business in bar iron has not improved, but producers of re-rolled steel bars anticipate an improved demand, as Continental prices are now practically non-competitive in the home market. Bar iron prices are unchanged, and re-rolled steel bars are quoted £7 15s. home delivery and £6 10s. per ton export. Scrap material is slow to move, but cast iron machinery is a shade firmer at £2 7s. 6d., with heavy steel unchanged at £1 15s. per ton.

Pig Iron.

Last week 700 tons of pig iron arrived in this district from Millom and Workington. Local makers have nothing fresh to report, the demand being still as a rule, easily supplied from stock.

Coal.

The demand for fuel for the home market has ncreased, and with the pressure for export supplies continuing, the scarcity of fuels becomes more pronounced, especially in the East of Scotland, where the effect of the "quota" is most apparent. Fifeshire and Lothians' screened steam coals are very scarce, as also are washed nuts. Pearls are distinctly stronger, owing in a measure to shipments to the Thames. Lanarkshire best splint is very firm, considerable quantities having been sold for shipment to the River Plate and West Italy. Total shipments during the past week amounted to 265,639 tons, against 261,896 tons in the preceding week, and 252,876 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

South Wales Trade.

It is difficult to say whether trade in South Wales as a whole is really better or not. The possibility of developments in the coal industry is being canvassed, every aspect receiving the utmost attention in the hope that something will emerge to the benefit of the whole of this district. The ship-repairing industry maintains a fair level, and there are no outstanding developments in other directions, though expectations of improvement in the iron and steel and tin-plate sections are entertained as reports come to hand of works here and there restarting. As a matter of fact, the unemployment registers for Wales and Monmouthshire at the end of last month showed that the position was worse than it was at the end of September by 5506, but this cannot altogether be taken as a guide for the reason that the situation of individual concerns changes very quickly, and it may be mentioned that during the past month nearly forty steamers belonging to Cardiff firms have been replaced in commission after being on the laid-up list for periods varying from two months to over a year. Although outward rates of freight are not better, hopes are held that trade will by the New Year broaden to the benefit of all concerned in industry.

The Coal Trade.

The coal export section is not without particular interest, though the figures of shipments last week issued by the Great Western Railway Company do not make very satisfactory reading. The total for the six ports under this company's control only came to 380,050 tons, which compares with 412,525 tons for the preceding week, and with 386,682 tons for the corresponding period of last year. It is noticeable that the returns for Swansea do not make such a good show, but it has to be admitted that the "Canadian" season has practically come to an end, and, furthermore, the recent congestion which prevailed at Swansea has meant that vessels have been diverted to Port Talbot, with the result that this week started with three idle tips at Swansea, while at Port Talbot there were six vessels waiting to berth. As a matter of fact, at the end of last week the conditions from the loading point of view were not at all good in this area, as the dock returns on Saturday showed that there were no less than forty-nine idle tipping appliances and only one vessel waiting, but as the result of arrivals over the week-end the figures were brought down to twenty-seven idle tips, while seven vessels were waiting. Newport of late has certainly experienced a bad time, and complaints have been made that that town is not getting a fair share of its legitimate trade, but that coals which should rightly be shipped at Newport have been transferred to Cardiff. It is difficult to substantiate this statement because a proportion of Newport coals has always been shipped at Cardiff. One thing is very clear, that Newport has suffered by the marked falling off in the demand for Monmouthshire coals, which are so suitable for locomotive purposes, two markets in particular which may be mentioned being the Irish Free State and Italy. It was mentioned only recently that the Great Southern Railway of Ireland has contracted for 30,000 to 40,000 tons of German coals, while recent statistics reveal that for the nine months ended September Germany's exports of coal to the Irish Free State amounted to 84,000 tons, as compared with less than 1000 tons for the corresponding period of 1931.

Coal Items.

In other directions there are interesting features about the coal trade. The British Admiralty has come on the market for about 20,000 tons of smithy smalls and coke, which, with its previous inquiry for other grades, brings up its total requirements to the neighbourhood of about 100,000 tons over the next twelve months. The report is just to hand that Spain is experiencing trouble with the miners in that country, apparently for the reason that the Government has declined further to limit imports of coal. From accounts to hand, the Spanish miners have come out on strike, but it is not expected that it will be of long duration. In the meantime the Spanish Naval Commission has asked for prices for about 8000 tons of Admiralty large coals for fairly early shipment. Local firms have been asked to quote on a f.o.b. basis and also c.i.f. Ferrol, Carthagena, and Cadiz, the quantities for the three ports being 2000, 3000, and 3000 tons respectively. The Belgian Cabinet has decided to increase the quota of foreign domestic coal, and negotiations are being opened with Germany for a modification of the provisional agreement between Belgium and Germany. The percentage of increase agreed to with Germany will automatically apply to imports of coal from this country and Holland. So far as France is concerned, the chartering of tonnage for the near French ports has slackened off to some extent, the reason being that import licences for this month in some cases are reaching the point of exhaustion, but still there is a good quantity of coals yet to go by the tonnage that has already been arranged. As regards household coals, it may be mentioned that the Executive Board of the South Wales District, Coal Mines Scheme, has advanced the minimum pithead prices of all house coals, with the exception of best qualities, by 1s. per ton.

Coal Trimmers' Wages.

As the result of a further meeting last week between the employers' and men's representatives on the National Joint Trimming Committee with respect to the demand of the shipowners for a reduction in the national coal-trimming tariff, agreement was come to on the basis of a 5 per cent. reduction to come into operation as from January next. The original application of the employers was for a reduction of 10 per cent. The position is therefore that from January 1st the rates will be 45 per cent. below the basic rates of 1920, which are 116 per cent. above the pre-war level. The basic rates for cargo are 6d. per ton for single deckers, 8d. per ton for two deckers, 10½d. per ton for three deckers, and 1s. 1d. per ton for four deckers. The basic rates for self and easy trimmers are 2½d. per ton for Class I., 3½d. per ton for Class II., and 4½d. per ton for Class III. vessels. Altogether, about 3000 men in South Wales are affected by the agreement.

The Tin-plate and Steel Trade.

Work is shortly to be restarted at Baldwins' Landore Steel Works, Swansea. Preparations are being made for the resumption, and it is announced that it will not be long before some of the furnaces are relighted. About 200 men will be taken on as against the normal number of 400. As the result of a joint meeting of representatives of the employers and workmen in the Welsh tin-plate trade, a scheme for the reabsorption of unemployed men has been adopted. The scheme is not of a hard and fast character, but the employers have accepted the principle of sharing work. Firms are to be approached, together with their employees, in order to ascertain what prospect there is of absorbing men in works now operating. There are 1500 to 1800 men at present in South Wales unemployed.

Current Business.

The market in steam coals from day to day displays very little variation. The demand for large coals is extremely quiet, though dry large form an exception, and command a premium on minimum prices of 3d. to 9d. per ton. Sized coals, particularly of low volatile, are firm and very scarce, while washed smalls move off freely and are about 1s. to 1s. 6d. above the schedule. Dry nuts and cobbles are to all intents and purposes a nominal market. Coke meets with slightly more inquiry, but patent fuel remains about steady. There has been no movement in pitwood.

"Soak the Rich."—Mr. E. Brotherton, general manager of the Hercules Cycle and Motor Company, Ltd., of Birmingham, has been good enough to send us a copy of a reprint of an American article which he has had made at his own expense. The article, bearing the arresting title "Soak the Rich," was written by Mr. F. Britten Austin, and appeared originally in the *Saturday Evening Post*, a well-known American paper. It is a very striking exposition of the illusion and dangers of excessive taxation, and, after an historical survey, used with much skill, analyses the incidence of taxation in this country and its effect upon real wealth. Mr. Austin is a confirmed believer in capital, and is convinced that excessive money collected by a government is industrially wasted. He makes his points with great ability and effectiveness. We do not know how many copies of the reprint Mr. Brotherton has had prepared, but we have little doubt that he will be able to satisfy any *bond fide* applicant for one.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Ernest Benn, Ltd., inform us that Mr. E. C. M. Shepherd has been appointed as their technical book manager.

Taskers of Andover, Ltd., inform us that the firm has been taken over by a new company called Taskers of Andover (1932), Ltd.

Crompton Parkinson, Ltd., informs us that it has acquired control of Derby Cables, Ltd., and that there will be no changes in the general policy of Derby Cables, Ltd.

Keyn and Lahy (1928), Ltd., Letchworth, inform us that they have appointed Mr. C. B. Unwin, A.M. Inst. C.E., late of the chief mechanical engineer's department, London Underground Railways, to be assistant general manager at their works.

James Pollock, Sons and Co., Ltd., 3, Lloyd's-avenue, have disposed of their position as representatives of J. and C. G. Bolinders Company, Ltd., of Stockholm, but all communications in connection with Bolinder engines and spares and for Bolinder woodworking machinery and cutters should be addressed to them until December 31st, 1932.

The English Electric Company, Ltd., Stafford, informs us that the agreement between the company and Mr. P. N. Rand, M.I.E.E., general sales manager, having expired, Mr Rand has intimated his intention not to renew it. His connection with the English Electric Company will therefore terminate at the end of November. Personal letters for Mr. Rand should be addressed c.o. The Royal Automobile Club, Pall Mall, London.

CONTRACTS.

Hancock and Co. (Engineers), Ltd., Croydon, have received two orders from the London, Midland and Scottish Railway Company, each for the supply of a very large oxygen cutting machine. The first machine has a cutting area of 50ft. by 5ft. 3in. and the second 47ft. by 5ft. 3in.

CATALOGUES.

Holden and Brooke, West Gorton, Manchester.—A pamphlet illustrating "Gorton" oil coolers.

John Fowler and Co. (Leeds), Ltd., Leeds.—Publication 497 on a 70 H.P. Diesel shunting locomotive.

Elliott Brothers (London), Ltd., Lewisham, S.E.13.—Catalogue 820 on Siemens thermo-electric pyrometers.

British Insulated Cables, Ltd., Prescot, Lancs.—The following catalogues:—"Paper Pinions, Ceiling Fans, Varnishes," "Joint Boxes," "Dynamos and Instrument Wires," "Jointing Materials and Accessories."

Punch Almanack, 1933.—With his old-fashioned courtesy, Mr. Punch has very kindly sent us a copy of his Almanack for 1933. We would be happy to reciprocate, but fear that he would find less enjoyment in our periodical than we do in his.

The Junior Institution of Engineers.—At the fifty-first Annual General Meeting of the Junior Institution of Engineers, held on November 11th, the following election of officers took place:—As Chairman, E. Ambrose, M.I.E.E.; as Vice-chairmen, A. E. Bingham, A.M.I. Mech. E., and H. P. Wright; as Hon. Editor, C. E. Atkinson, A.M.I.E.E.; as Hon. Treasurer, W. M. Hurrell; as Hon. Librarian, F. Squirrell; as Senior Councillors, A. P. Morris, H. J. N. Riddle, and G. H. Willett; as Junior Councillor, W. Wood; as Hon. Auditors, F. Burgess, J. Duguid, T. C. Morewood, and L. O. Stone.

Anglo-German Club.—On the evening of Tuesday, November 15th, we were invited to the formal opening of the library, lounge and other rooms of the Anglo-German Club at its new home at 6, Carlton-gardens, London, S.W.1. Visitors were received by the President, the Right Hon. Viscount D'Abernon, and Lieut.-Col. the Master of Semphill, who referred to the growth of the Club's activities and expressed the hope that it would form a common meeting place for the nationals of both countries and would help on both business and cultural interests. We may record that one of the early special events will be the informal dinner of the Engineers' German Circle, which is to be held on Monday, December 5th, at the Anglo-German Club. We would congratulate Mr. Nevin du Mont, the Committee, and Lieut.-Colonel G. Cawson, the Secretary, on the excellent provision which has been made for members of the Club in the securing of such fine and well-situated premises, of which an excellent description appears in the current issue of the *Anglo-German Review*.

Engineers' German Circle.—Since the inaugural meeting of the Engineers' German Circle on Monday, October 10th, which was referred to in The Engineer of October 28th, two further successful meetings have been held at the Institution of Mechanical Engineers, at which from seventy to eighty members attended. On Monday, October 31st, Mr. R. E. Strub, of W. H. Allen, Sons and Co., Ltd., Bedford, gave a paper on "New Developments in Diesel Engine Construction." He showed interesting comparisons illustrating the progress made in oil engine design, both as regards running gear, balance, and the use of welded structures instead of cast iron crank cases and frames. On Monday last, November 14th, Dr. R. K. Fischer, of the Technical Department of Foster Wheeler, Ltd., of London, spoke on "Modern Oil Refinery Practice." He dealt with the old and new methods of refining crude oil and discussed the latest practice in which, after heating, the various fractions are separated in vertical towers with or without vacuum. Dr. Fischer discussed questions of heat exchange and thermal efficiency, and his lecture was greatly appreciated, giving, as it did, technical particulars of an entirely new field of development.

Association of Past and Present Students of W. H. Allen, Sons and Co., Ltd.—Every year at about this time a very pleasant function is held in London. The members of the Association of Past and Present Students of W. H. Allen, Sons and Co., Ltd., meet together to dine. This year's dinner was held last Saturday, November 12th, and was very well attended and much enjoyed by all those who took part. The speeches were of a high, but suitably diverting, order, and, as usual on these occasions, commendably short. Mr. G. King-Johnson, an old pupil, took the chair, and replied to the toast of "The Association," proposed eloquently by the chairman of the company, Mr. R. W. Allen, who compared the state of the country now with its position twelve months ago in the days of the financial crisis. The toast of "The Firm" was proposed by Mr. B. W. Pendred and Mr. H. G. Allen, in response, spoke optimistically of the returning prosperity of both the firm and the country. He announced that Allen's had, during the last few years, found a large number of new customers. The response by Mr. J. F. Haseldine to the toast of "The Guests," proposed by Mr. J. B. Urquhart, brought the official proceedings to a close, but no dinner of the Association is complete without a speech and a statement of the accounts from its genial secretary, Mr. H. R. Howlett. Altogether, it was a very pleasant and enjoyable function.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 23/6
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	15/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 7 6	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. Coast—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold-blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a); 4 0 6 (b); 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
Lancs.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 7 6 to 10 10 0	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 5 0—10 Ton Lots and Upwards Delivered Glasgow Stations.	10 0 0
„ (Gal. Cor. 24 B.G.)	For Canada	10 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 15 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets	11 5 0 to 12 15 0	10 0 0
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/9 to 16/3
Block Tin (cash)	156 10 0
„ (three months)	157 5 0
Copper (cash)	32 17 6
„ (three months)	33 2 6
Spanish Lead (cash)	12 8 9
„ „ (three months)	12 17 6
Spelter (cash)	15 10 0
„ (three months)	15 17 6
Manchester—	
Copper, Best Selected Ingots	37 10 0
„ Electrolytic	38 10 0
„ Strong Sheets	65 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11½
Lead, English	14 7 6
„ Foreign	12 15 0
Spelter	15 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/7½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 15 0	8/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£22 5 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	11/–
„ „ „ 1 p.c. carbon	£42 12 0	14/–
„ „ „ 0·70 p.c. carbon	£44 0 0	16/–
„ „ „ carbon free	1/– per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 10 0 scale 6/– per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/–
„ „ Ell	15/6
„ „ Splint	15/6 to 16/6
„ „ Trebles	15/– to 15/6
„ „ Doubles	13/–
„ „ Singles	11/–
Ayrshire—	
(f.o.b. Ports)—Steam	12/6
„ „ Jewel	16/6
„ „ Trebles	15/6 to 16/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/–
Screened Navigation	16/6 to 17/6
Trebles	17/– to 18/6
Doubles	13/6 to 14/6
Singles	11/6 to 12/–
Lothians—	
(f.o.b. Leith)—Best Steam	13/–
Secondary Steam	12/6
Trebles	15/6 to 16/–
Doubles	12/6 to 13/–
Singles	11/–

(8) N.W. Coast— ENGLAND.

Steams	20/– to 21/6
Household	32/6 to 52/6
Coke	19/– to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 30/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

Sheffield—	Inland.	Export.
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	23/– to 24/–	—
South Yorkshire Seconds	18/– to 21/–	—
Derbyshire Best House	22/– to 23/6	—
Derbyshire Best Brights	18/– to 20/–	—
Screened Seconds	17/6 to 19/–	—
Kitchen Coal	16/6 to 17/6	—
Best Screened Nuts	17/– to 18/6	—
Small Screened Nuts	16/– to 16/6	—
Yorkshire Hards	17/– to 18/–	—
Derbyshire Hards	17/– to 18/–	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/– to 8/6	—
Blast-furnace Coke (Inland)	10/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6		

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 31/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	20/–
Pitwood (ex ship)	21/6 to 22/–
Swansea—	
Anthracite Coals:	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 34/–
Red Vein	22/– to 26/6
Machine-made Cobbles	37/6 to 48/6
Nuts	36/6 to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/6
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Public Works.

THE dubious outlook for all branches of industry at the approach of winter has awakened more interest in public works schemes which are supposed to offer the only means of promoting industrial activity, though no one believes that money spent on building schools and hospitals, and in constructing roads and canals, will bring much work to manufacturers, and particularly to the engineering and metallurgical branches. There is an impression that these works will appeal to the public and inspire confidence and that the circulation of money will encourage spending and release some of the huge mass of unproductive savings. If that money were rendered partially available by means of public loans there would be no difficulty in carrying out the programme of national economical equipment. Recently, there was a question of the Government issuing such a loan, but efforts are being made to provide funds in the Budget for the execution of a new plan which the Minister of Public Works has prepared for a series of undertakings that will cost something like 18,000 million francs to be spread over a period of five or six years. It is really a third instalment of the original plan that was started two years ago and suspended through lack of funds. The idea of the scheme was to provide the country with cheap energy, greater docking and transport facilities and lower production costs, so that it will derive the utmost benefit from the trade revival when it comes. Besides roads and canals, and rural electrification the scheme embraces railway electrification and harbour improvements and the development of civil aviation. State subsidies will be granted to municipal and other bodies for the carrying out of productive works, and the State will participate in hydro-electric undertakings and such enterprises as that for rendering the Rhone navigable over its whole length, and providing further supplies of hydro-electric energy. The Paris Municipal Council has a big scheme for the "embellishment" of the city, and an extension of the Metropolitan Railway to the suburbs. Even the Trans-Saharan railway scheme is being pushed forward persistently and is held by its promoters to come within the limits of the programme, because it would provide work for 30,000 men over a number of years, while its interest to makers of railway material is obvious. Still, it is uncertain yet what the Budget will provide. The Government hopes that it will be able to dispose of 3500 million francs for 1933, and a similar amount in the following year.

Shipping Restrictions.

At the launching of the "Normandie," Monsieur Fould, President of the Chantiers de Penhoët, reminded his hearers that on the occasion of the visit of the Institution of Naval Architects to Saint-Nazaire last year, he pleaded for the co-operation of British shipping interests in an attempt to limit the total tonnage and the size of ships. The matter was dealt with last week at the monthly meeting of the Association des Grands Ports Français, when the proposal to limit the size of ships was approved of by Monsieur de Raulin on the ground of cost which burdened the navigation companies and imposed further heavy charges on the port authorities for deepening harbours and providing accommodation for huge vessels. Monsieur Wohl, Director of the Transport Section of the International Chamber of Commerce, declared that no restriction could be imposed on the size of ships, which was determined by the conditions of competition amongst maritime countries. If, he said, the total tonnage could not be limited by international agreement, it was hopeless to expect to do anything at all. This opinion was confirmed by Monsieur Cangardel, director of the Compagnie Générale Transatlantique, who stated that the highest speeds were required by American passengers and that, consequently, bigger ships had to be built in order to provide comfort and security. That was an inevitable course of evolution. At its monthly meetings the Association des Grands Ports Français will continue to discuss proposals put forward to remedy the crisis in merchant shipping.

State Orders.

Manufacturers are appealing to the Government to give instructions to the State services and to the railway and other enterprises which are carried on under concession from the State, to place all their orders at home so as to provide employment to engineering firms, which are becoming increasingly short of work. The demand is perfectly legitimate if French makers can supply what is needed. They recognised the difficult situation of the arsenals and other services which are obliged to insist upon guarantees that French makers cannot give in the case of special machines they do not manufacture. In addition, foreign prices are low, a fact which the French attribute to dumping. Whether that term is justified or not, it is obvious that when foreign manufacturers lay themselves out to supply the world with special types of machines, they will always produce them more cheaply than the French, who can only look to a limited home market. French manufacturers do not make grinding machines, for example, nor can they satisfy the arsenals with certain classes of machines and accessories for ship equipment which have to be obtained from abroad because their use in other navies offers the best guarantee of reliability and efficiency. Machines imported have been evolved out of long experience, and the affirmation of French makers that they can lay themselves out to produce such machines if the State services are less exacting as regards references and price will not impress State engineers who are held responsible for failures. Nevertheless, this agitation for the exclusion of foreign machines should not be lost sight of, because it tends to limit the opportunities for exchanges which are necessary if there is to be any readjustment of the economic situation. While the engineering trades naturally insist upon having a monopoly of their own market, at a time when they are all short of work, it is worthy of remark that essentially French industries producing luxury articles for which there is a world market urge that as they contribute most to the national prosperity their foreign markets should be recovered even at the expense of other industries that cannot exist without complete protection.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

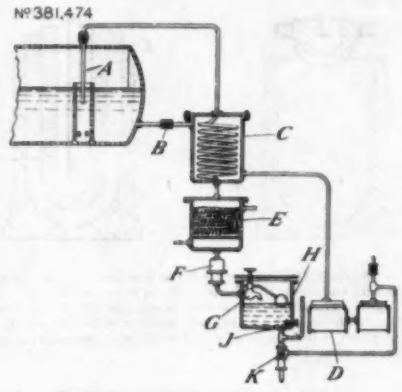
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

381,474. March 15th, 1932.—CONTROLLING THE SALINITY OF WATER IN BOILERS, *United Water Softeners, Ltd.*, 51, *Chancery-lane, London, W.C.2.*

This is a continuous system of blowing down boilers. The blow-down connection is made through the top of the boiler, as shown at A. B is the feed water delivery. The blow-down pipe passes through the heat exchanger C, through which the feed is delivered by the pump D. The blow-down water passes

Nº 381,474



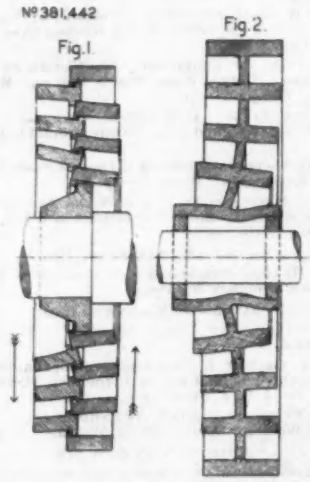
through the filter E and the thermostatically controlled valve F, which can be adjusted to close if the blow-down temperature exceeds a predetermined limit. The water then goes through the ball valve G into the open tank H. The outlet from this tank can be adjusted to maintain any desired rate of flow through the system by the valve J. There is also a shut-off valve K in the outlet, which is so controlled by the admission of steam to the feed pump that the blow-down is stopped when the pump is stopped.—*October 6th*, 1932.

TURBINE MACHINERY.

381,442. February 10th, 1932.—A THIN-WALLED DISC WITH HIGH RESISTANCE TO THRUST, Dr. U. Meininghaus, Margarethenplatz 4, Mulheim-Ruhr, Germany.

This invention is concerned with the construction of the discs of radial-flow turbines in which the steam flows outwardly on one side of the disc and inwardly on the other side, as shown by the arrows. The result is that the disc is subject to an end thrust and also to a graduated expansion and contraction on

Nº 381,442



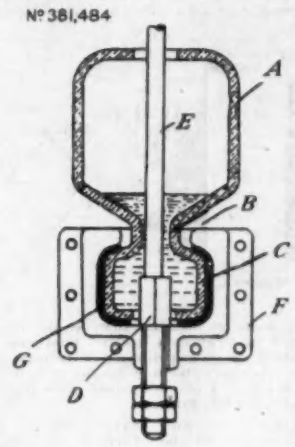
account of the temperature drop of the steam. The inventor offers two alternative designs of disc. In that shown by Fig. 1 the blade rings are made separately and are shrunk one on to the other with locking shoulders to take the end thrust. The joints are sufficiently tight to prevent the leakage of steam but yet are flexible enough to allow of thermal distortion. The second design, shown in Fig. 2, relies on the flexibility of the disc, and it is stipulated that the thickness of the disc should be equal to, or less than, the radial thickness of the rings.—*October 6th*, 1932.

SWITCHGEAR.

381,484. March 29th, 1932.—SWITCHES WITH ARC EXTINGUISHING CHAMBERS, International General Electric Company, Inc., of 120, Broadway, New York, U.S.A.

This invention relates to extinguishing or explosion chambers for electric switches, particularly to those of the kind in which the contact breaking takes place within a conducting or semi-conducting liquid, such as water. According to the invention the employment of ceramic materials and glasses in extinguishing chambers is made possible by embedding the chamber wholly or partially in a metal casing. A is the upper portion of an explosion or extinguishing chamber, which is represented in section, and which consists, for example, of porcelain. At B it is contracted into a tube or passage to form upper and lower compartments, and in the lower compartment C there is an opening through which a stationary contact socket D projects into the interior of the chamber. A movable contact rod E co-operates with the contact D. The rod E passes through the restricted passage B with slight clearance. The opening in the upper portion A of the chamber is, however, considerably larger than the rod, so that a considerable increase of

Nº 381,484



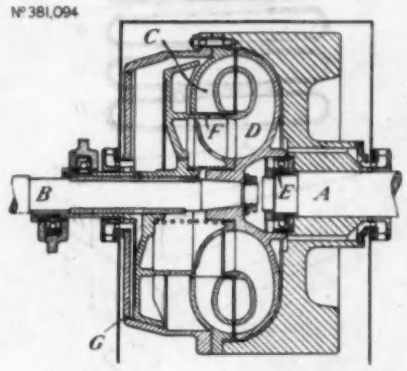
pressure in the portion A of the chamber is prevented. Round the portion C of the chamber the metal casing F is placed, and consists of two parts clamped together. After the parts have been clamped together the space between C and F is filled with a suitable cement G.—*October 6th*, 1932.

TRANSMISSION OF POWER.

381,094. March 21st, 1932.—HYDRAULIC CLUTCHES, Dr. W. Voith, Dr. H. Voith, and H. Voith, Heidenheim, Württemberg, Germany.

In this clutch a combination of the hydraulic and friction principles is employed. The hydraulic clutch, of the Föttinger type, is used to start the drive and then the friction clutch makes a positive connection between the two shafts. In the drawing the clutch is shown open at the top and closed below.

Nº 381,094



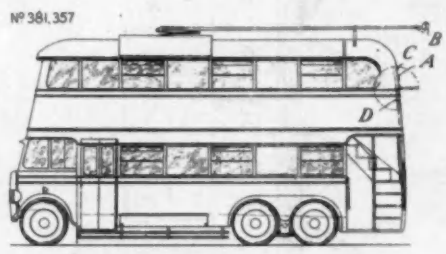
A is the engine shaft and B the driven shaft. The driving impeller of the hydraulic clutch is shown at C and is fixed to the fly-wheel. The driven impeller D is supported by the bearing E. A sleeve F can be slid axially between the two impellers, as shown in the top half of the drawing, to check the circulation of water and thus put the clutch out of action. As this sleeve is withdrawn the hydraulic clutch takes up the drive and finally the cone clutch G, which is attached to the sleeve, takes up the load.—*September 29th*, 1932.

MOTOR CARS AND ROAD TRAFFIC.

381,357. October 27th, 1931.—ELECTRICALLY PROPELLED VEHICLES, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2, and Percy Enville Warner, of "Mayfield," Chapel-lane, New Longton, near Preston, Lancashire.

This specification describes an arrangement for inspecting the trolley head of electrically propelled vehicles such as tramcars or omnibuses. A platform for this purpose is shown at the rear of a trolley omnibus with a covered upper deck. When

Nº 381,357



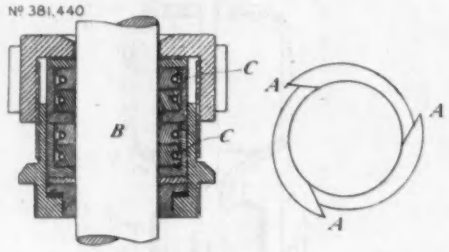
in use the flap A projects horizontally outwards below the trolley head B and access may be obtained to it through the opening C in the back of the upper saloon. The flap may be larger than the opening and when not in use it may take up the position A. Preferably, however, the flap is made smaller than the opening, and when not in use it swings through it into the position D. The opening A is disposed immediately above the staircase, so that a man may climb from a stair through the opening on to the platform, details of which and the method of support are fully described.—*October 6th*, 1932.

MISCELLANEOUS.

381,440. February 5th, 1932.—STUFFING BOXES, M. Deventer, Güstener Weg 4, Strassfurt-Leopaldhall, Germany.

The essential feature of these packings is that the rings are made of sections, circumferentially, which abut one on the other on semi-tangential faces, as shown at A A A. The sections are closed on the shaft B by the garter springs C C. It will be

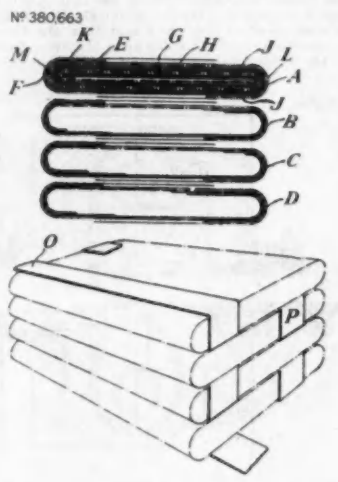
observed, says the inventor, that the invention represents a fundamentally different mode of solution from that heretofore usual. Previous designers started on the basis that the segments should wear uniformly all over. The invention, on the contrary, teaches that the segments should be arranged so as to be slidable readily on one another so that each segment is worn



considerably more at one end than at the other: that is, generally to form in effect a wedge. That there may be projecting points at the outer periphery of the worn segments is of no practical importance, because it is found by experiment that the spring exercises a uniform radial pressure on the several segments.—*October 6th*, 1932.

380,663. December 9th, 1931.—Electric Condensers, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

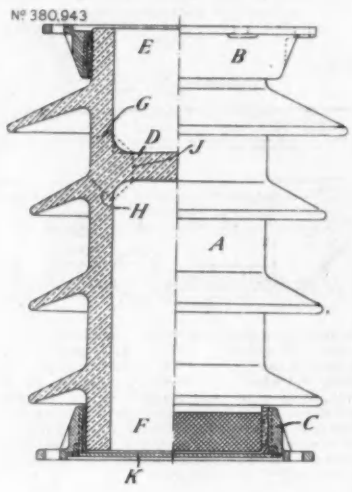
The object of this invention is to facilitate the process of connecting condenser elements in parallel. The condenser is formed by the separate elements A, B, C, and D. E and F are metal foils, and G and H dielectric layers. The foil F (broken line) is exposed at J, and the foil E (thick line) is exposed at K. The other elements are made in a corresponding manner. On superposing the elements, the foils at J abut against the corresponding foils, and the foils K on the corresponding foils between the adjacent elements, so that the condenser elements are connected in parallel without it being necessary to fit tags or similar arrangements to the foils. The dielectric strips G and H are preferably provided with apertures or cut



away parts at the points J and K, so that the coatings E and F are not bare at the edges L and M of the elements. In order to avoid overheating when a number of elements are connected in parallel, it is advisable to interlace each element alternately in a pair of copper bands O and P, the copper bands resting on the exposed parts J and K of the elements. The insulating strips and the electrode strips are wound together in the same direction, to form a reel, with the ends of the strips overlapping, and the reel is then flattened.—*September 22nd*, 1932.

380,943. September 24th, 1931. Electric Insulators, Steatite and Porcelain Products, Ltd., of Stourport, Worcester, and Geoffrey Herbert Halton, of Mount Villa, Stourport.

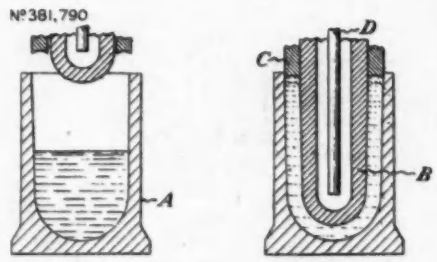
This invention relates to electric insulators of the high-voltage type for supporting electrical appliances generally and air-break isolating switchgear in particular, such insulators being of the type having a series of rain sheds. The insulator consists



of a hollow cylindrical body A of porcelain with the usual rain sheds. The ends of the insulator are adapted to lie within metal cups B C, the upper one of which is secured to the appliance to be supported and the lower one to the supporting base. The insulator may, however, be provided with a metal cup at one end only. Within the hollow body of the insulator there is a bridge D, which divides the interior into two portions E and F. In the event of the insulator becoming soiled the portions E and F become charged to the voltage of the appliance and the support respectively. This means that the bridge D will be subjected to a high voltage, but by virtue of its arrangement is able to withstand this voltage. On the other hand, when the bridge D is provided at the upper extremity of the insulator it is the wall adjacent to the metal cup B which experiences this high voltage. Owing to the form and position of the metal cup, the electrical stresses in the material are very high and the electrical stresses in the air adjacent to the metal cup are also very high and consequently the voltage to which the insulator may be subjected safely is less in such a construction than in one embodying the invention. In order to avoid the formation of lines of high electric stress G, H, and J, such as are liable to be formed when the corners are sharp angles, such as indicated by the dotted lines, the corners are well rounded as shown in full lines. The performance of the insulator may also be improved by closing the open ends of the insulator by discs, one of which is shown at K, lying within the metal cups. These discs serve to prevent contamination of the inner surfaces.—*September 29th*, 1932.

381,790. December 29th, 1931.—Making Hollow Ingots, E. F. Jones, Victoria Station House, Victoria-street, London, S.W.

This invention is concerned with the production of hollow ingots for making tubes and the like. The ingot mould A is partially filled with molten metal and a plunger B is forced



down through the centre to form the hole. The plunger is guided by the collar C, which, in turn, is forced down to solidify the ingot. The collar also acts as a stripper while the plunger is being withdrawn, which action is facilitated by the rapid cooling of the plunger by means of water circulated through the pipe D.—*October 13th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Inst. of Automobile Engineers.—Park Lane Hotel, Piccadilly, W.1. Annual dinner. 7 for 7.30 p.m.

Inst. of British Foundrymen: Sheffield and District.—Grand Hotel, Sheffield. "Mammoth Castings for the Cunarder Building on the Clyde," Mr. F. Swift. 7.45 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. "Modern Hydraulic Operation of Machine Tools," Mr. H. C. Town. 6 p.m.

Inst. of Welding Engineers.—Chamber of Commerce, Birmingham. "Eye Protection during Welding Operations," Mr. R. B. Butler. 7 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "The Anderson Rotary Piston Steam Engine," Mr. H. P. H. Anderson. 7.30 p.m.

Overhead Lines Association.—Georgian Restaurant, Harrods Stores, Knightsbridge. Third annual Conversazione. 8 p.m.

Physical Society.—Imperial College of Science and Technology, S. Kensington. Meeting. 5 p.m.

West of Scotland Iron and Steel Institute.—Royal Technical College, Glasgow. "Chemistry of a Fire-brick," Mr. J. F. Hyslop. 7.15 p.m.

TO-DAY AND SATURDAY, 19TH.

Public Health Exhibition and Congress.—Royal Agricultural Hall, Islington, N. Daily.

SATURDAY, NOVEMBER 19TH.

Inst. of Civil Engineers.—Students' visit to Battersea Power Station.

Inst. of British Foundrymen.—Loughborough College, Loughborough. "The Uses of Refractory Materials in the Foundry," Dr. J. G. A. Skerl. 6 p.m.

Inst. of Municipal and County Engineers: S. Eastern.—Meeting at Woking. Council Offices, Woking. 11.30 a.m.

MONDAY, NOVEMBER 21ST.

Hull Association of Engineers.—Beverley-road Baths, Hull. Whist Drive and Dance. 7.15 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow, C.2. "Hydraulic Brakes for Motor Vehicles," Mr. F. G. Parnell. 7.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C.2. Discussion, on "Loudspeakers." Opener, Dr. N. W. McLachlan. 7 p.m.

Inst. of Electrical Engineers: S. Midland.—The University, Birmingham. "Electric Lighting of Buildings," Messrs. J. W. T. Walsh and A. B. Read. 7 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Steam Valves," Mr. D. Doulton. 6.15 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Fothergill Trust Lecture, "Fire Fighting," Comm. A. N. G. Firebrace, R.N. (retd.). 8 p.m.

Wolverhampton and District Engineering Society.—Victoria Hotel, Wolverhampton. "Story of Bakelite Resinoid," Mr. G. Dring. 7 p.m.

TUESDAY, NOVEMBER 22ND.

British Science Guild.—In the Goldsmiths' Hall, Foster-lane, E.C. Norman Lockyer Lecture, 1932, "Industrial Research and the Nation's Balance Sheet," Sir Frank E. Smith, K.C.B. 4.30 p.m.

Illuminating Engineering Soc.—Visit to Building Centre, Ltd., 158, New Bond-street, W.1. 6 p.m.

Inst. of British Foundrymen.—King's Head Hotel, Coventry. "The Magnetic Moulding Machine," Mr. T. W. Bullock. 7.30 p.m.

Inst. of Electrical Engineers: London Students.—Savoy-place, W.C.2. "Modern Systems of Electrical Installation for Large Buildings," Mr. R. C. W. Joyce. 7 p.m.

Inst. of Electrical Engineers: Scottish.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner. 6.30 p.m. for 7 p.m.

Inst. of Electrical Engineers: S. Midland Students.—The University, Birmingham. "Some Applications of Automatic Control Gear to the Starting of Alternating and Direct Current Motors," Mr. M. W. Hime. 7 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, W.1. "Rays and Radiation," Mr. E. N. da C. Andrade. 5.15 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Corrosion Resistance and its Measurements," Mr. H. T. Shirley. 7.30 p.m.

WEDNESDAY, NOVEMBER 23RD.

Inst. of Automobile Engineers.—Engineers' Club, Manchester. "Study of Piston Temperatures and their Relation to Piston Design," Mr. H. Wright Baker. 7 p.m.

Society of Glass Technology: London.—At Works of Rockware Glass Syndicate, Ltd., Greenford. "Refractories for Tank Furnaces," Mr. J. B. Murgatroyd. 7.30 p.m.

THURSDAY, NOVEMBER 24TH.

Inst. of Civil Engineers: Birmingham and District.—Chamber of Commerce, Birmingham. "Research at the Engineering Department of the National Physical Laboratory," Dr. H. J. Gough. 6 p.m.

Inst. of Mechanical Engineers: Yorkshire.—Hotel Metropole, Leeds. "Factory Expense, and its influence upon Administration," Mr. J. M. Newton. 7.30 p.m.

Inst. of Structural Engineers.—10, Upper Belgrave-street, S.W.1. "Reconstruction of the Ryde Pier and Contingent Works," Mr. C. J. Jacksman. 6.30 p.m.

Manchester Association of Engineers: Students' Section.—Y.M.C.A. (Restaurant Club Room), Peter-street, Manchester. "Automatic Railway Signalling," by Mr. S. J. Adamson. 7.30 p.m.

Royal Aeronautical Society.—The lecture by Squadron Leader H. Leedham has been postponed.

FRIDAY, NOVEMBER 25TH.

Chartered Inst. of Patent Agents.—At Inst. of Mech. Engineers, Storey's-gate, S.W.1. Jubilee meeting. 3.45 p.m.

Chemical Engineering Group.—Burlington House, W.1. "Problems of Emulsion Persistence," Dr. W. Clayton. 8 p.m.

Inst. of Electrical Engineers: N.E. Centre, Students.—Armstrong College, Newcastle-upon-Tyne. Address by Mr. C. Turnbull. 7.15 p.m.

Inst. of Electrical Engineers: S. Midland.–Grand Hotel Birmingham. Annual dinner. 6.30 for 7 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1 "Development of Modern Glass Bottle Making Machinery,' Mr. F. G. Pasotti. 7.30 p.m.

Manchester Association of Engineers.—Engineers' Club Albert-square, Manchester. Quarterly meeting. Paper, "Practical Boiler Testing," by Mr. F. Buckingham. 7.15 p.m.

North-East Coast Inst. of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. "Rejuvenation of Ships and their Machinery," by Mr. Andrew Hamilton. 6 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, W.1. Discourse by Mr. H. Knox-Shaw. 9 p.m.

Soc. of Consulting Marine Engineers and Ship Surveyors: Scottish District.—39, Elmbank-crescent, Glasgow, C.2. Film, "Oxy-acetylene Welding and Cutting." 7 p.m.

SATURDAY, NOVEMBER 26TH.

Inst. of Electrical Engineers: Midland Students.—Visit to the works of James Booth and Co., Ltd., Argyle-street Works, Nechells, Birmingham. 3 p.m.

Inst. of Metals.—Joint meeting with Inst. of British Foundrymen. Armstrong College, Newcastle-upon-Tyne. "New Demands on the Brass Foundry," Mr. J. Arnott. 7.30 p.m.

MONDAY, NOVEMBER 28TH.

Bradford Engineering Society.—Technical College, Bradford. Cinematograph film. "Metal Treatment by the Oxy-acetylene Process." 7.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Fothergill Trust Lecture, "Safety of Life from Fire," Lieut.-Col. Guy Symonds, D.S.O. 8 p.m.

TUESDAY, NOVEMBER 29TH.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Chromates and Chromium in Relation to the Corrosion of Iron," Dr. U. R. Evans. 7.30 p.m.

WEDNESDAY, NOVEMBER 30TH.

Inst. of Civil Engineers: Manchester and District.—36, George-street, Manchester. "Refuse Disposal," Mr. J. T. Kendal. 6 p.m.

Inst. of Welding Engineers.—College of Technology, Manchester. "Flame Cutting by Hand and Machine," Mr. C. G. Bainbridge. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C.2. "Recent Developments in Electric Lighting," Mr. W. J. Jones. 8 p.m.

THURSDAY, DECEMBER 1ST.

Inst. of Metals: Birmingham Section.—University, Birmingham. "Oil-fired Furnaces," Mr. S. F. Unwin. 7 p.m.

FRIDAY, DECEMBER 2ND.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Thomas Low Gray Lecture, "Eight Years' Salvage Work at Scapa Flow," Mr. E. F. Cox. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal Meeting. Discussion on Engineering Topics. 7.30 p.m.

SATURDAY, DECEMBER 3RD.

Inst. of Electrical Engineers: Meter and Instrument Section.—Florence Restaurant, 56, Rupert-street, W.1. Annual dinner, 6.45 for 7 p.m.; reunion, 9.30 p.m.

TUESDAY, DECEMBER 6TH.

Inst. of Metals: Swansea Section.—Y.M.C.A., Swansea. "Some Industrial Pyrometry Problems," Dr. E. Griffiths, F.R.S. 6.15 p.m.

THURSDAY, DECEMBER 8TH.

Inst. of Metals: London Local.—Joint meeting with Inst. of British Foundrymen. Charing Cross Hotel, W.C.2. "Some Aspects of the Selection of Engineering Material," Mr. L. B. Hunt. 8 p.m.

FRIDAY, DECEMBER 9TH.

Inst. of Electrical Engineers: N.E. Centre, Students.—Armstrong College, Newcastle-upon-Tyne. "Applications of Electricity on Ships," Mr. N. H. Denholm. 7.15 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, "A Comparison between Communistic and Capitalistic Methods of Organisation," introduced by Mr. J. L. Hodgson. 7 p.m.

Inst. of Metals: Sheffield Local.—In Non-ferrous Section of Applied Science Dept. of University, Sheffield. "Degreasing and Cleaning (Vapour Cleaning)," Mr. W. F. Jesson. 7.30 p.m.